MACHINERY.

July, 1906.

THE CONSTRUCTION OF A BRIDGE MODEL.

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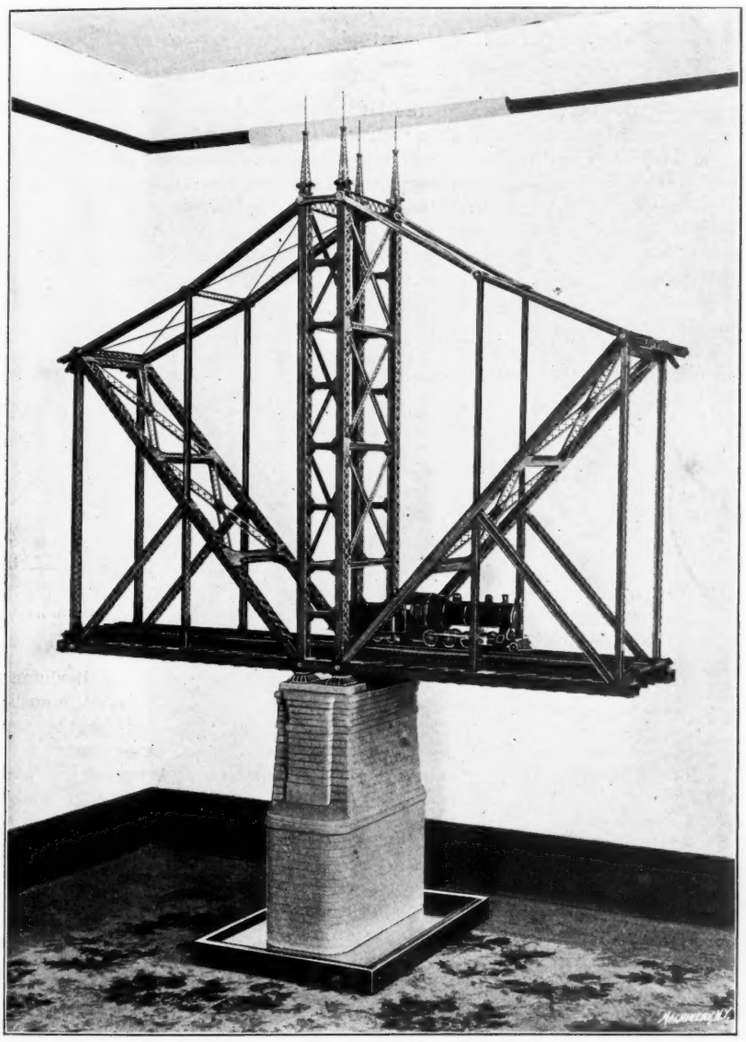
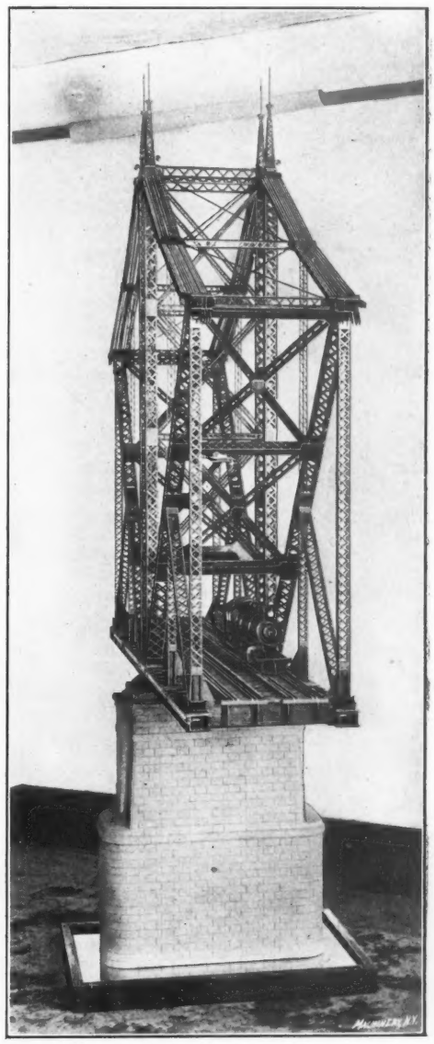
THE model shown in the halftones, Figs. 1 and 2, is of a portion of the Wabash Pittsburg Terminal Railway Co.'s double track cantilever bridge, over the Monongahela River at Pittsburg, Pa. This bridge was designed by Messrs. Boller & Hodge, consulting engineers, New York, and was built and erected by the American Bridge Co. It is 1,504 feet long, center to center of anchor piers, 812 feet, center to center of main piers, and 126 feet 7 inches high, center to center of pins at the tower, total weight of steel, 7,000 tons; total cost including foundation and masonry, $1,000,000.





Figs. 1 and 2. Side and Front Views of Model of the Wabash Cantilever Bridge at Pittsburg.

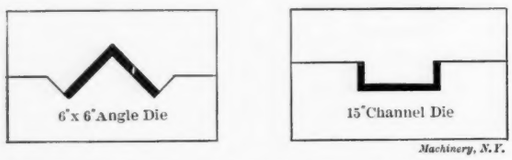
The model is of the north shore pier and two panels of the superstructure either side of the tower representing about 172 feet of the bridge and it shows the typical construction of the whole span. It is about 6 feet long, and 7 feet 6 inches high, being made to a scale of ⅜ inch to the foot. The inclined and vertical web members are box sections, being built up of L's and plates riveted together and latticed on either side with flat bars. The lower chords are also box sections of similar construction. The wind bracing is of both box and I-section form, the I-section being composed of four L's latticed together with small flat bars. The floor system is of built beams, or plate girders, composed of 4 L's and a web plate riveted together in the form of an I. The girders which run transversely are called floor beams, and support the longitudinal girders or stringers which carry the ties. The main web members and chords of the whole structure are pinned together with steel pins.

Prior to starting the construction of this model, it was found that the small brass angles and channel sections of the sizes required for the work could not be obtained, which necessitated the making of dies with which to draw them. These dies were filed out of 3/16-inch steel, and made in two parts, being backed off on the side through which the brass was entered. It took six sets of dies to turn out the different sizes of material.

In drawing the different sections the dies, Figs. 3 and 4, were held in a bench vise, and brass ribbon of the proper width was shaped into form by hand, and forced through the die far enough to attach a come-along, to which was hitched a small tackle. By this means, the different shapes were drawn in lengths that would cut up economically, usually from 7 to 8 feet long.

One great difficulty experienced, was getting the brass rib-

bon in stock of proper widths and thicknesses, out of which to make the different sections; and it was practically for this reason the model was made to the scale of ¾-inch to the foot, each 1/32 inch equalling 1 inch at that scale. For instance, ¾-inch ribbon (12/32) made the 6 x 6-inch L. The web plates were also made of brass ribbon but of a heavier gage than that used for L's, the width ranging from 9/16 to 1 1/16 inch, and in several instances when the right width could not be obtained, it was necessary to shear the plate to width by hand. This was done by scratching a line on the ribbon with a scratch gage, and then with shears cutting off 1/16 inch or 1/8 inch as might be required from strips running in lengths from 20 to 30 feet. These plates in every



Figs. 3 and 4. Drawing Angles and Channels from Strip Brass.

instance had to be peined on the edge to bring them to a straight line, as the shearing caused them to have a lateral wind.

Having sufficient material prepared to start the four main posts, the next thing taken up was the riveting together of L's and plates in the form of channels. On account of the wavy condition in which the L's came from the dies, it was apparent there would be trouble in getting them riveted to the plates straight and true, and to accomplish this, the following scheme was devised. Three strips of wood about five feet long were fastened to a bench, and on one of the strips the pin centers of the member was accurately laid off. Between these centers, the strip was divided into spaces of about 1 inch; these were for the location of the rivets which were to hold the L's and plates together. The L's were now straightened by hand and forced into the slots, thus being held true to line.

The web plate which had previously had gage lines scratched on it the whole length, was laid on top of the L's,

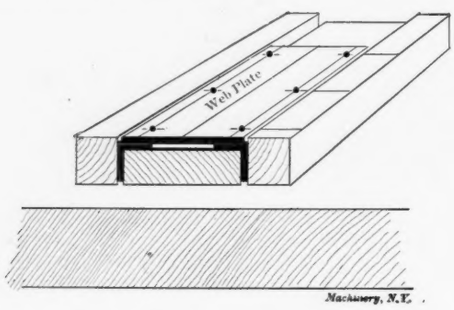


Fig. 5. Building Up a Channel Section.

and held temporarily in position with small brads, spaced about 6 inches apart down the center of the plate. (See Fig. 5.) The rivet and pin centers were then scratched across the plate, after which the same was taken up, and center punched. The plate was then put back in place and holes drilled through the L's and plate at the same time, after which they were taken from the form and riveted together. Eight of these sections were thus made, after which they were formed into posts in the following manner: a strip of wood of proper width and thickness was screwed to the bench on which were marked off the pin centers, and the location of the tie plates.

Two channel sections were then clamped in position, one on each side of the strip of wood, as shown in Fig. 6. The tie plates which had previously been made and tinned on their edges, were laid in position, and soldered fast with a blow-pipe. The lattice bars were then put on in a similar manner, one side of the post being completed at a time. The screws were then removed from the form and the lattice bars and plates of the opposite side were then soldered in place, after which the wood center was drawn out, leaving the completed post straight and true. The lattice bars were made of tin varying in width from 3/32 to 3/16 inch. They were sheared from sheets by hand. The lattice work was made on a form, and soldered together in full panel lengths. (See Fig. 7)

The I-section bracing was made in similar manner to the channel portion of the post, with the exception that rivets were only used at the ends to secure the L's to the connection plates. The L's were all tinned on one edge. The bottom ones were forced into slots on top of which was laid the lattice work, and at each end a tie-plate. The top L's were then laid on as shown in Fig. 8 and held in position from point to point by a steel pencil, while the pieces were soldered together. Having bored the holes in the end, through the plates and L's, the piece was removed from the form and riveted.

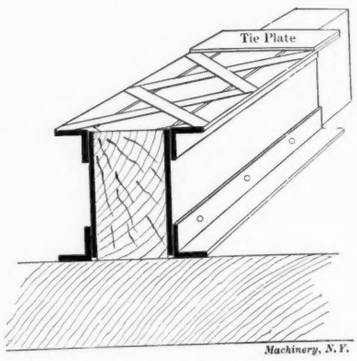


Fig. 6. Assembling a Latticed Column.

The bottom chord which is about 6 feet long was made in one piece. It is a box section, and of the same construction as the main posts already described. The only particular

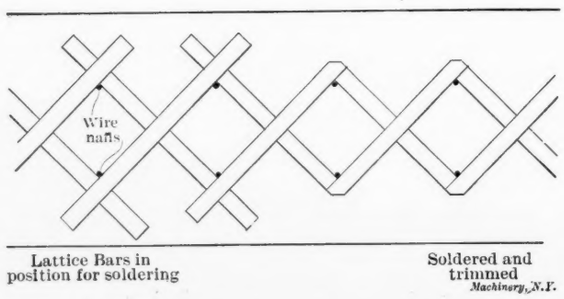


Fig. 7. Method of Soldering the Lattice Bars.

difference being in the latticing which is of small channels 3/16 inch in width, instead of flat bars. This latticing was not made in long strips, as was the latticing for the other members. Each X was made separately, being composed of three pieces of channel, a long piece and two short pieces with a small splice-plate to join the two short pieces together where they intersected at the center. They were soldered together on a form similar to that used for flat latticing.

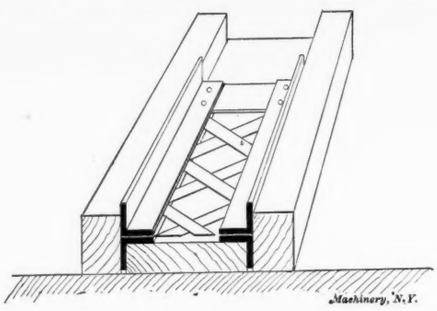


Fig. 8. Assembling the Latticed I-sections.

The sides of the chords have four lines of rivets along them, there being about 900 rivets in each, or 1,800 rivets in all, in the two chords.

The most difficult piece to make in the whole bridge was the box strut or brace on the lever arm end of the model. This strut was latticed on two sides with small L's, which came together at their intersections, and at the ends on small plates, the other two sides being latticed with flats. The strut is actually about 12 inches long, and is composed of 142 individual pieces. The two sides having the angle lattice

were made first. They were then clamped to a wooden center, in the same manner as were the web members, and the flat latticing was then soldered on. Great care had to be exercised in the soldering of this and other similar pieces, as the least excess above the amount of the heat required to make the solder run would have caused the whole strut to drop apart. The four finials on top of the main posts also gave considerable trouble on account of the great number of small parts, each containing 124 individual pieces. All curved L's such as those on the small struts between the main tower posts were bent to an iron template to insure uniformity.

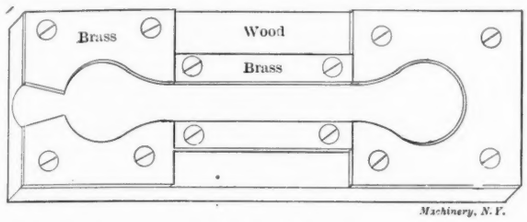


Fig. 9. Eye Bar Mold.

The floor beams and stringers were made in a similar manner to the I-sections, two angles being held in position by wooden strips, on top of which were placed a web-plate and the other two angles. They were then soldered together, after which holes were drilled through the angles and plates and riveted. These stringers and floor beams having been completed, the stringers were braced together in pairs with cross frames and laterals, and then riveted to the floor beams. They in turn were tap screwed to the vertical web members of the trusses. Tap screws were used, as it was necessary to take the model apart for shipment.

then substituted for the brass ones, as shown in Fig. 9, with better results, and finally after several successive attempts, the mold having become thoroughly heated, a full bar was cast, after which no further trouble was experienced. The bars were all drilled from an iron template to insure accurate length, center to center of pin holes.

The pins which hold the model together are made of steel, and vary in diameter from 9/32 inch to 15/32 inch, and in length from 1½ inch to 3 inches.

The pier is made of wood and is hollow. The stones instead of being carved on the surface, were made of blocks of thin wood and bradded on, the whole then being painted and sanded.

It required 42 of the original shop drawings of the bridge to construct this model. Throughout the work, no attempt was made to fit one finished piece with another; the drawings for each piece being accurately followed, and when the whole was completed, no difficulty was experienced in putting it together. The model is complete in every detail, as far as the structural work is concerned, except in the thickness of material and the number of rivets.

In order that the reader may get an idea of the enormous amount of work on a model of this kind, it may be stated that there were used, 698 lineal feet of drawn shapes, 200 lineal feet of web plates, 4,500 lattice bars, and 7,200 rivets. There were over and above 8,800 individual pieces. It was estimated that for the soldering of lattice bars alone there were over 14,000 little pieces of solder used. These had to be handled individually. It took about 1,000 hours to complete this work; the cost of material was about $50.

The locomotive shown in Figs. 1 and 2 is constructed of paper and wood and gives an idea of the comparative size of the bridge.

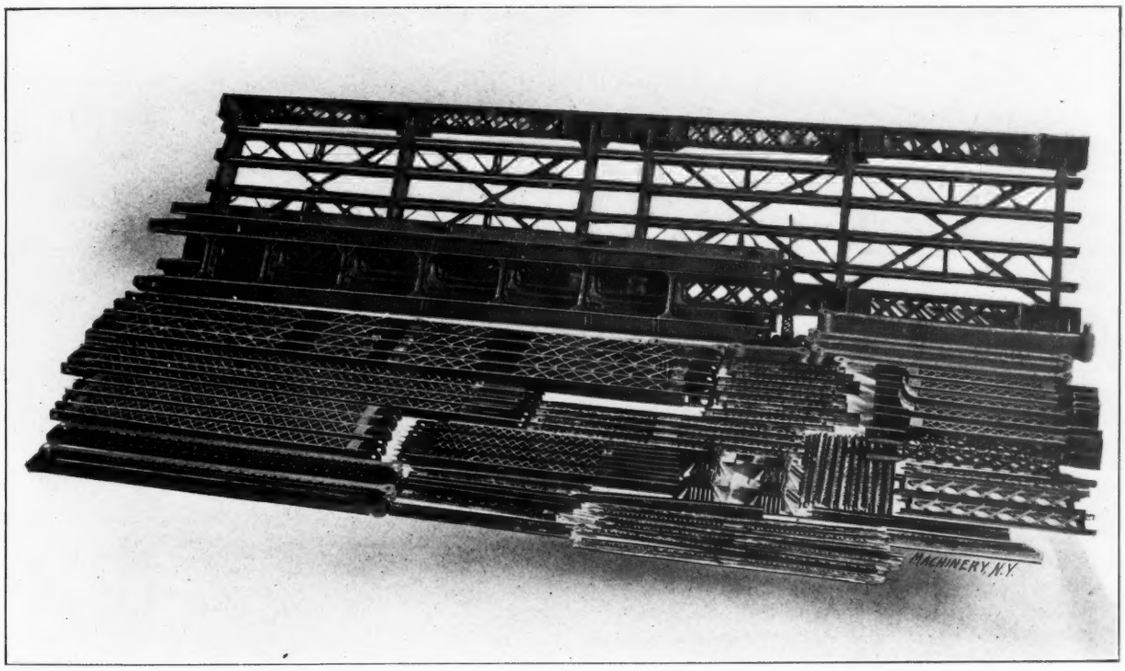


Fig. 10. The Completed Members, ready for Assembling.

In the upper chord there are five panels of I-bars, 28 bars to the panel and of four different lengths. To have cut these out by hand would have been a difficult task, and as the making of dies with which to stamp them would have been too expensive, it was decided to try to cast them of type-metal. The largest bar was 18 inches long, 7/16 inch wide, 1/16 inch thick. On account of the thinness of the bars it was doubtful if it would be possible to cast a bar so thin and of such length. The first attempt was made with a brass mold, but the metal refused to flow down further than one-third the length of the mold. The heating of the mold was then suggested, but on account of the time that would be lost in allowing the same to cool, it was thought best to try some other means for overcoming the trouble. Wooden sides were

[As an example of modelmaking this bridge model ranks high, having been built from the working drawings with scrupulous regard for accuracy of detail; the most important omission is the substitution of solder for rivets in the lattice work. The constructor is a structural engineer, with the firm who designed the bridge, and when it is known that he built the model nights and holidays in his home workshop with a few hand tools, its accomplishment naturally claims more attention from amateurs and others who sometimes indulge in model work than would be bestowed on it if done in a regular shop having a good tool equipment. Aside from this the methods of getting the required sections and assembling them so as to get the members straight and without wind are well worth the attention of any mechanic.—EDITOR.]

THE STRENGTH AND DUCTILITY OF STEEL.

F. E. CARDULLO.

The two most important characteristics of a steel, or indeed of any material with which the designer has to do, are its strength and its ductility. He is, in general, more interested in these qualities in steel than in any of the other of his materials, for steel having both of them in unusual degree, is naturally used in all constructions where their presence is of unusual importance. These qualities, fundamental, yet ever variable, depend on two things: first the kind and proportion of the substances present in the steel, and second the treatment of the steel during the process of manufacture.

It has often seemed curious to the writer that so little is known of the effects of the elements commonly present in steel. We know in a general way that carbon will make a steel hard, phosphorus brittle, manganese tough, and so on through the list. However no two authorities agree on the desirability of various proportions of the elements, and many are not even agreed as to whether or no some of the elements are injurious. It was with the idea of reconciling some of this warring testimony that the writer was moved some months ago to undertake to find out, if possible, HOW strong, and HOW tough the various elements present made the steel.

The elements commonly present in steel, besides the iron that forms the base of the metal, are carbon, manganese, silicon, sulphur and phosphorus. Besides these, many or all of which are present in every steel, special steels contain nickel, chromium and tungsten. The three latter elements confer valuable properties of hardness, toughness and temper on steels. Many other elements are sometimes found in steels, but after as much of an investigation as the limited data on the subject will allow, the writer is compelled to state that so far as he can discover, there are no elements other than these, that have an appreciable effect upon the strength or ductility of a steel.

It may be well at this point to understand in a broad and general way the method of manufacture of steel. There are at present in commercial use three kinds of steel, made by three different processes, known as the Bessemer, the open-hearth and the crucible processes. The first produces the cheaper grades of steel, used for rails and structural work, the second a better grade of steel, used for boiler plate, bridge work and heavy forgings, and the third a very fine quality of steel, used for tools, small forgings and high-class machine work. In general the process is the same in each case, namely, to purify and refine cast iron, to add to this refined product such elements as are necessary to give the required strength and temper, to cast the resulting mass into an ingot, and then to shape and refine that ingot by forging or rolling. There results a product whose strength we will measure in pounds per square inch, and whose ductility we will express by stating the percentage a piece originally eight inches long, will stretch before rupture.

Among chemists the amount of the various elements present is expressed in "points"; that is, in hundredths of one per cent of the whole mass by weight. Thus a steel having thirty points of carbon has in every pound of its mass .0030 pounds of carbon. The same quantity is more often expressed as .30 per cent, or as we say, thirty hundredths per cent. We are not compelled to estimate the amount of the substances present in this way, and indeed when special accuracy is sought, we often express the quantity of a substance present in thousandths of one per cent. We might have then a steel containing three and a half points of sulphur, or .035 per cent sulphur, or thirty-five thousandths per cent of sulphur, the three expressions being identical in meaning.

Without going into the very tedious details of finding the equations, the writer begs leave to present the two expressions in this article as representing the strength and ductility of a steel in terms of its chemical composition. Since the proof of the pudding is in the eating, we will then take up the analysis of several commercial steels, and compare their calculated strengths and ductilities with those shown by actual test. The formula for the strength of a steel has the form—

$$\text{Strength} = 36{,}000 + 630\ C + 500\ S + [1{,}000 - 5\ (Mn + C)]\ Mn + 1{,}000\ \sqrt{C \times P}$$

Where the strength is obtained in pounds per square inch,

C = the number of points of carbon present in the steel,

S = the number of points of sulphur present,

Mn = the number of points of manganese present,

P = the number of points of phosphorus present.

On looking this equation over we can come immediately to a conclusion as to the effect of the various impurities present on the strength of a steel. We see that a perfectly pure iron, if it could be obtained, would have a strength of 36,000 pounds per square inch, and that any of the impurities noted in the equation, when present in the proportions in which they are found in ordinary steel, add to the strength of the steel. Some add more than others, and they all depend more or less on each other for their effect. Thus, the more carbon there is present the greater the effect of the phosphorus. The more carbon and manganese together the less the effect of the manganese. For instance, in a steel containing only ten points of manganese, and no carbon, each point of manganese adds 950 pounds to the strength. If there were one hundred points of manganese, instead of ten, each one would add but 500 pounds, and if there were one hundred points of carbon also, the manganese would add nothing to the strength of the steel.

Authorities differ as to the effects of the different elements. For instance, some tell us that the sulphur weakens the steel, instead of strengthening it. Others will give different relations between the effects of the other elements present. I can only say first that the relations given agree substantially with the best authorities, and second, that they agree even more substantially with the observed facts in the case.

The formula for the ductility of a steel has the form

$$\text{Ductility} = 39.00 - 0.12\ Mn - 0.18\ (C + P) - 0.4\ S - \sqrt{Si} - 0.1\ (P \times \sqrt{C})$$

Where the ductility is obtained in per cent elongation before rupture,

Si = the number of points of silicon present in the steel,

C, Mn, S and P are the same quantities as before.

On inspecting this second equation, we see that all of the elements which add to the strength of the steel, also add to its brittleness, or what amounts to the same thing, take away from its ductility. We see that the effect of the phosphorus depends on the amount of the carbon present, in somewhat the same way that it did before. We see also that the element silicon detracts considerably from the ductility of the steel, without adding anything to its strength, and we may therefore conclude that it is a very mischievous element to have present. Carbon and manganese add most to the strength in proportion to what they detract from the ductility, and are therefore the most desirable elements to have present in the steel.

It is, however, neither desirable nor possible to have a steel free from all elements but these. The other elements are present as impurities in the iron ore and the fuel, which are used at every stage of the process of steel making, and while it is generally possible to reduce them to a very small amount, it is impossible to eliminate them entirely. Then, too, the presence of some of these impurities is absolutely necessary in order that the steel shall be sound and readily worked. The element silicon in particular has a highly beneficial effect, in making the steel more sound and homogeneous. Steel having a very small percentage of impurities has two faults. In the first place, when the liquid mass is cast into an ingot, what impurities there are will have a tendency to gather into one place, thus forming spots too hard and brittle, in a steel otherwise too soft and weak. This trouble is termed segregation, and is obviated by a sufficient proportion of impurities, the most efficient in overcoming it being silicon. The second fault is the presence of gas in the cooling mass in the form of bubbles. These bubbles form vacant spaces in the ingot, and when they are flattened out in working, they become flaws in the finished piece. The remedy is again a larger proportion of impurities, and again the most useful is silicon. So that an element that adds nothing to the strength and takes away

not a little from the toughness of a steel, is nevertheless one of its most valuable components.

Although these equations give a very close approximation to the strength and ductility of most steels, there is no reason why any steel should not depart widely, in its properties, from those indicated. It will be found that the steel may be stronger or weaker than the equations would indicate, but never of a very much greater ductility, except where there is a large proportion of nickel present. The reason for this is that the strength of a steel depends on the manner of working it as well as on its chemical composition. For instance, if it is not thoroughly worked, it will be soft, weak, and not very tough. The more thoroughly it is worked, the stronger and tougher it will become. A plate two inches thick will not by any means be as strong and tough as a plate one-fourth of an inch thick, for the reason that the thinner plate is much more thoroughly worked. These equations apply to plate of three-eighths inch thickness, or equivalent section in other forms than plate, and an appropriate correction must be made when the thickness differs materially from that value. This correction will be about one per cent reduction in strength and ductility for each eighth of an inch above three-eighths inch thickness.

Excessive working, on the other hand, adds very much to the strength of a steel, but is at the expense of its ductility. For instance, the strength of a steel may be about doubled by wire drawing, but the ductility will then become a very small fraction of one per cent. In the case of a steel containing a large proportion of carbon, the manner of cooling after working will have a very important effect. Sudden cooling or hardening, as we commonly call it, has the same effect as cold working. The amount of the effect will depend on the proportion of carbon present, the temperature from which it was cooled, the temperature to which it is cooled, and the length of time in which the cooling takes place.

Thus we see that the strength of the same piece of steel may vary from time to time, according to the kind of treatment which it last received, and the ductility may vary in a similar manner. The treatment assumed is that the steel was thoroughly worked at the proper heat, and was then allowed to cool slowly in the open air. This is the condition in which we find steel ordinarily on the market. Even with the same composition, and when treated in the same way, two pieces of steel will differ considerably in their physical properties. In a series of fourteen tests made upon bars of the same section, and rolled from the same heat, the strengths of the different specimens varied by as much as four per cent, and the ductilities by nearly ten per cent. The equations are intended to apply to the average, and not the extreme cases.

The formulas are thus an indication of the previous treatment of the steel. If the steel is stronger and less ductile than the chemical analysis would indicate, it is because the metal has been worked at too low a temperature, or else has been hardened. If it is too weak and brittle, it has not been sufficiently worked. In general, the closer the strength of the metal agrees with its calculated strength, the greater will be its ductility. The formulas thus point out to us where the mistakes have been made, and how they may be rectified. Not only this, but they enable us to calculate the composition which will meet given specifications, determining the maximum allowable quantity of impurities, and thus tell us what ores and processes we may use to get given results.

As an example of the use of the formulas, we will take first the case of a steel intended for rifle barrels, and reported by Thurston. This steel had the following composition: Carbon, .325 per cent; manganese, .677 per cent; sulphur, .057 per cent; phosphorus, .620 per cent; silicon, .047 per cent. The actual tested strength of this steel was 99,640 pounds, and its elongation 19.00 per cent. From our formulas we have:

Iron		36,000
630 C	630 × 32.5 ..	20,500
500 S	500 × 5.7....	2,850
$[1{,}000 - 5\ (Mn + C)]\ Mn.$	[1,000—5 (67.7 + 32.5)] 67.7	33,800
$1{,}000\ \sqrt{C \times P}$.....	$1{,}000\ \sqrt{32.5 \times 2}$	8,050
	Strength ..	101,200
Iron		39.00
0.12 Mn	0.12 × 67.7.....	8.12
0.18 $(C + P)$	0.18 (32.5+2.0)	6.20
0.4 S	0.4 × 5.7	2.28
$\sqrt{Si}$	$\sqrt{4.7}$	2.16
0.1 $(P \times \sqrt{C})$	$0.1\ (2.0 \times \sqrt{32.5})$	1.14
		19.90
	Ductility	19.10 per cent

This is an excellent metal, properly worked, and its only fault is a rather large amount of sulphur.

A series of tests was made by government experts between 1875 and 1878, to determine as far as possible the relation between the strength and composition of steels. From the instances reported of their work by Thurston in his "Materials of Engineering" I have selected at random five steels. Their chemical analysis, their calculated strengths and ductilities, and the value of the strengths and ductilities found by actual test, are given in the following table:

	No 1.	No. 2.	No. 3.	No 4.	No. 5.
Carbon	.009	.049	.460	.908	1.142
Sulphur	.009	.007	.002	.002	none
Phosphorus	.084	.179	.020	.014	.020
Silicon	.163	.219	.121	.141	.204
Manganese	.020	.063	none	.036	.282
Calculated strength	41,700	54,900	74,400	106,200	130,500
Actual strength	43,000	55,000	71,000	118,900	130,400
Calculated ductility	31.88	25.25	25.50	16.08	9.15
Actual ductility	29.67	25.50	20.17	11.08	8.67

Taking the steels in their order, we see that the first was cold worked, in order to raise its strength. If this metal had four points of carbon additional, in place of four points of phosphorus, it would be very much improved in strength and ductility. The second steel is properly worked, but it has entirely too much phosphorus. The third is of excellent composition, but it was not sufficiently worked. The fourth was worked at too low a temperature, or more probably was allowed to cool too fast. The fifth was perfectly treated, and its only fault is a little more silicon than is necessary.

* * *

In the construction of a certain magnetic clutch it was desired to interpose a thin brass disk between the magnetic member and its keeper, or mating disk, to overcome the effects of residual magnetism. The attempt to make the thin brass disk an attachment to one of the cast-iron plates was a failure; the rivets were quickly torn out of the brass disk and the latter ruined. Then the expedient of using the brass disk without securing it to either of the clutch disks was tried with complete success. The wear on the brass plate was found to be very slight, and it filled its function satisfactorily in every respect. This experience has been paralleled many times. Another example of quite different character might be mentioned and that is the false valve seats frequently used on locomotive cylinders. It is usual to make the valve seat for slide valves so as to give an inch or more wearing surface. When the metal has worn away and the remainder of the cylinder is still in good shape it is customary to put on a false valve seat which is a piece shaped like the original seat, but only 1⅛ or 1¼ inch thick. It was formerly the practice to secure this seat to the cylinder by screws or dowels. These quickly worked loose with the usual result of ruining the valve and sometimes the cylinder. It was finally proposed that no attempt be made to hold the seat to the cylinder, but to provide it with lugs fitting inside of the steam chest, so as to hold it in position and to let the steam pressure take care of holding it down firmly enough to prevent leakage. The plan was entirely successful and is now the most common practice wherever false seats are used.

* * *

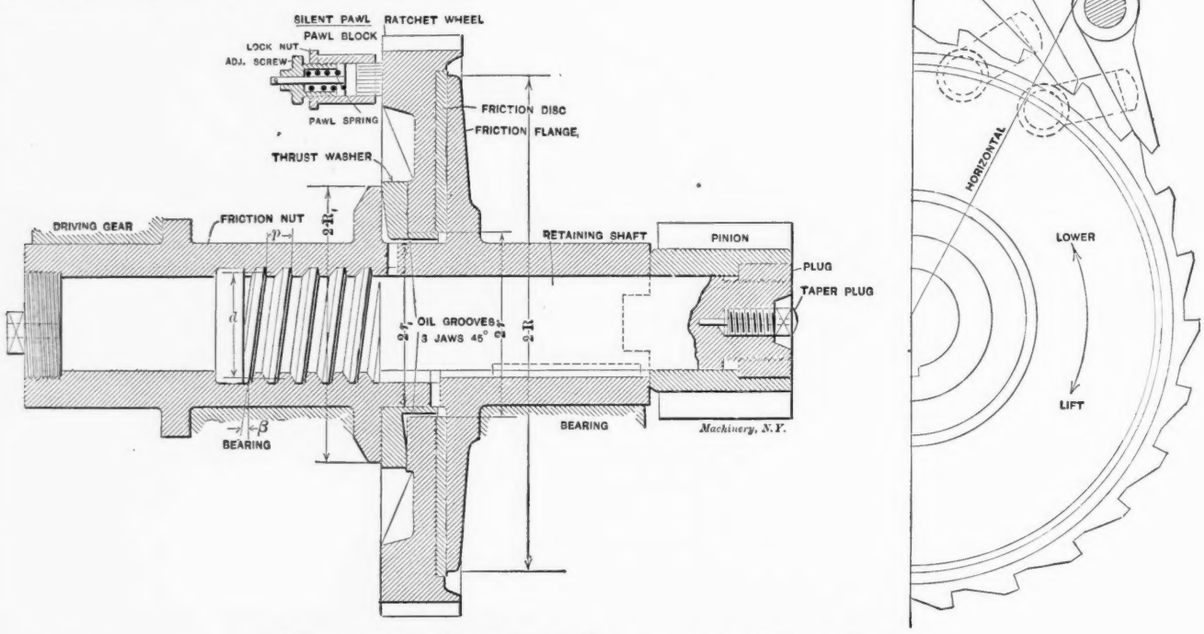
The largest gasholder in the country and possibly in the world is said to be that under construction at the Astoria works of the Consolidated Gas Co. of New York. It is 300 feet in diameter and will rise to a height of 260 feet when fully inflated. Its capacity will be 15,000,000 cubic feet.

DESIGN OF THE WESTON LOAD BRAKE.

ULRICH PETERS.

To safely hoist, hold and lower a load, hoisting machinery is usually equipped with so-called safety, automatic, or retaining brakes. These brakes permit a load to be lifted freely by the motor and lock the brake by the gravity action of the load as soon as the lifting torque of the motor ceases to act in the hoisting direction. The load is retained by the brake in any position and it is only when the motor runs in the lowering direction that the acting power of the brake is diminished, allowing the load to descend. The speed at which the load drops is regulated and determined by the lowering speed of the motor, while the brake, in the meantime, absorbs by friction the greater part of the potential energy of the dropping load, and generates heat in the brake.

As an example for calculation, the writer has selected one of the best mechanically designed brakes, which is shown in the sectional views. The ratchet is free to revolve when hoisting, but is held by two silent pawls from turning in the lowering direction. The friction nut is geared to the motor and the retaining shaft with gear pinion leads to the hoisting drum. The retaining shaft and friction nut are threaded either right- or left-hand, according to the hoisting direction. The friction flange is keyed to the retaining shaft and mates



The Mechanism of the Weston Load Brake for Cranes and other Hoisting Machinery.

with the friction nut by means of three jaws which have about 15 degrees angular play. The friction flange drives the pinion direct through tongued and grooved projections between the pinion and flange. Any tendency of the load to revolve the retaining shaft when the motor is at rest, causes the friction flange with friction disk to be pressed against the ratchet wheel and the thrust washer of the nut, due to the screwing action of the threads. The friction of this washer against the ratchet wheel, which, as already explained, does not turn in the lowering direction, is sufficient to hold the load. Upon starting the motor to lower, it turns the friction nut and relieves a certain amount of pressure on the washers, until the pressure is overcome so far as to permit the load to revolve the friction flange in unison with the speed of friction nut, or motor. The heat generated in the brake is therefore an easily determined quantity and in direct proportion to load and lift, and on this account sufficient radiating surface must be allowed in the brake, so as not to burn the oil. In hoisting, the jaws of the friction nut and flange engage, thus relieving the brake of all friction.

The moment of friction, in inch-pounds, of a washer between two plane disks, when the pressure is evenly distributed over the whole surface, is expressed by the formula

$$M = \frac{2}{3} fP \frac{R^3 - r^3}{R^2 - r^2},$$

Where P = axial force; f = coefficient of friction; R = outer radius of ring, and r = inner radius of ring.

Theoretically, as well as in practice, the outside of the friction disk wears away faster than the inside, with the result that the pressure becomes unevenly distributed, being greater at the inner and less at the outer edge, which latter part is worn away much faster, so that for the above formula we may write,

$$M = \tfrac{1}{2} f P (R + r) \qquad (1)$$

Same can also be said about the thrust washer, so that

$$m = \tfrac{1}{2} f_1 P (R_1 + r_1)$$

Hence, the combined moment of friction is equal to

$$M + m \qquad (3)$$

As we have seen above; the friction work, which must be transformed into heat, is in turn radiated by the brake. It is evident that sufficient radiating surface must be allowed for the washers, and average practice calls for about 0.0003 to 0.0005 square inch for each foot-pound destroyed per minute. Or, in other words, one square inch of washer surface is sufficient for 3,333 to 2,000 foot-pounds per minute. Letting the lifting capacity of the crane = T in tons, and the lowering speed = S in feet per minute, the required combined area of friction and thrust washer is from

$$A = 0.6\, S\, T \text{ to } A = S\, T \qquad (4)$$

in square inches.

After having determined the required area of washers, it is now up to the designer to place the brake on the proper speeded shaft, where the axial pressure due to the threads of the friction nut and retaining shaft can be made to give the least wear. The best results have been obtained in practice at about 100 revolutions per minute of retaining shaft at the maximum lowering speed.

The following equations apply to angular thread screws for figuring the axial pressure P when the torque or turning moment L of load is acting on the retaining shaft. f_2 = coefficient of friction of screw and nut; other dimensions are shown in cut.

$$P = L \frac{2\,(\pi\, d - p\, f_2 \cos \beta)}{d\,(p + \pi\, d\, f_2 \sec \beta)}$$

In the above equation we see that the axial pressure is in direct proportion to the torque L. This torque must be taken

up by the friction moments m and M of washers, as given in the formulas 1 and 2. By substitution we obtain

$$f(R+r)+f_1(R_1+r_1) > \text{or} = d\,\frac{(p+\pi\,d\,f_2\sec\beta)}{(\pi\,d-p\,f_2\cos\beta)}.$$

from which formula the proportion of the pitch p and other parts, as angle β, middle screw diameter of screw, etc., can be checked against the radii R, r, R_1 and r_1, when the friction of washer, thrust washer and screw are obtained from reference tables for the different materials.

* * *

REDUCING GUN RECOIL.

The reaction or kick of a gun is not measured entirely by the momentum imparted to the projectile by the burning powder, but a considerable portion is caused by the acceleration of the burning gases themselves. For example, the free recoil of a .50-caliber rifle weighing about 8½ pounds and firing a cartridge containing 100 grains of black powder and 450 grains of lead, is about 25 foot-pounds, as actually demonstrated by experiment. The muzzle velocity of the bullet is about 1,400 feet per second. Now, since the momentum of the gun and the momentum of the bullet are equal, $W \times v = w \times V$, in which W = the weight of the gun; V = velocity of the bullet; w = weight of the bullet; v = velocity of the recoil of the gun. Substituting the known qualities in the example in question we have $8\frac{1}{2} \times v = \frac{9}{140} \times 1{,}400$ or $v = 10.6$ feet per second, velocity of recoil. By the formula $E = \frac{W v^2}{2g}$ it is calculated that $E = 15$ foot-pounds, nearly, = recoil of the gun, but the actually measured recoil as previously stated is 25 foot-pounds, the excess of 10 foot-pounds respresenting the recoil due to the 100 grains of powder, the gases of which escape from the gun with a much higher velocity than the bullet the moment the latter has left the muzzle. The fact that smokeless powders develop a much greater energy for the same weight than black powder explains why they give less recoil with the same or even higher projectile velocities. The reaction due to the expanding powder gases has been utilized in the McLean invention to reduce the recoil. The scheme is simply to divert the gases backward by a deflector as they leave the muzzle. In small arms, holes are drilled diagonally in the muzzle of the gun so that the gases shoot backward, and thus instead of adding to the reaction caused by the bullet a considerable reduction is effected, it is claimed. Suppose in the case in question where the reaction was 25 foot-pounds, 10 of which is due to the reaction of the weight of the burning powder itself, that all the powder gases could be reflected directly backward; then instead of having a reaction of 25 foot-pounds it would only be 5 foot-pounds, inasmuch as 10 foot-pounds would be subtracted from 15 foot-pounds, instead of being added to it.

* * *

An interesting form of piston packing was recently described in *Engineering*, which is made at the Craigton Engineering Works, Craigton, Glasgow; it is designed for use in steam engines, gas engines, pumps, air compressors, etc. It consists of three rings, the two outer rings being the packing rings proper, while the center ring is a tension ring. This ring has about double the amount of spring power possessed by the other two rings, and its construction is such that it does not touch the cylinder walls, its pressure being transmitted to the two side rings instead. The angle made by its side is such that the resultant side pressure tends to lock the bearing rings in the groove and thus produce a semi-solid piston. Hence it does not have the defect common to steam set packing rings of wearing the cylinder bore large at the ends when the steam pressure is greatest. The packing is made of a special cast-iron mixture for steam, etc., but when used for water pumps the rings are made of a special bronze. The packing is particularly recommended for superheated steam with high piston speeds, and it is claimed that it does away with the chattering that takes place with some other forms of rings. The construction is simple, being straight lathe work, with no hand fitting whatever required.

HORSE POWER TRANSMITTED BY BELTS.

F. WACKERMANN.

Engineers' textbooks give much and varied data for calculating the number of horse power that may be transmitted by belts; nevertheless, the following rules and tables used by the transmission department of the Jones & Laughlin Steel Co. may be of interest.

The centrifugal tension due to a strip of belt one inch square and one foot long, moving at a velocity of V feet per second = $0.012\,V^2$, weight of belt (leather) taken at 56 pounds per cubic foot.

Working tension of belt = T.

t = thickness of belt in inches.

Effective tension of belt = $T - 0.012\,tV^2$.

$$\text{H. P.} = \frac{(T - 0.012\,tV^2)\,V}{500}$$

T is taken as follows:

45 lbs. per inch of width for single belts 3-16 inch thick.
80 " " " " " " double " 3/8 " "
110 " " " " " " triple " 9-16 " "
145 " " " " " " 4-ply " ¾ " "

From the above data the following table has been calculated:

H. P. = 0 when $T = 0.012tV^2$ or at the following speeds:

8,485 feet per minute for single belts.
8,000 " " " " double "
7,659 " " " " triple "
7,616 " " " " 4-ply "

This table shows that there is no advantage in speeding belts up to more than 4,400 to 4,800 feet per minute and demonstrates the folly of using excessively high speeds. The number of horse power given can only be increased by sacrificing the life of the belt.

TABLE GIVING THE NUMBER OF HORSE POWER TRANSMITTED BY BELTS ONE INCH WIDE, CONSIDERING THE EFFECTS OF CENTRIFUGAL FORCE, SO THAT THE TENSION ON BELT IS CONSTANT AT ALL SPEEDS.

Speed in Feet per Minute.	Thickness of Belt.				Speed in Feet per minute.	Thickness of Belt.			
	Single.	Double.	Triple.	Four-ply.		Single.	Double.	Triple.	Four-ply.
100	.14	.24	.33	.44	3400	3.89	6.74	9.10	11.96
200	.27	.48	.67	.88	3600	4.03	6.95	9.35	12.28
300	.41	.73	1.00	1.32	3800	4.14	7.12	9.55	12.57
400	.54	.96	1.33	1.75	4000	4.24	7.26	9.70	12.73
500	.68	1.21	1.66	2.19	4200	4.33	7.36	9.79	12.84
600	.81	1.44	1.99	2.62	4400	4.39	7.42	9.83	12.88
700	.95	1.68	2.31	3.05	4600	4.43	7.44	9.80	12.84
800	1.08	1.93	2.64	3.48	4800	4.45	7.42	9.72	12.71
900	1.21	2.15	2.96	3.90	5000	4.45	7.37	9.56	12.50
1000	1.34	2.38	3.28	4.32	5200	4.43	7.26	9.34	12.20
1100	1.47	2.61	3 59	4.73	5400	4.38	7.10	9.05	11.80
1200	1.60	2.85	3.90	5.14	5600	4.31	6.92	8.69	11.30
1300	1.73	3.07	4.21	5.55	5800	4.21	6.65	8.25	10.70
1400	1.86	3.30	4.51	5.94	6000	4.09	6.35	7.73	10.00
1500	1.98	3.53	4.81	6.34	6200	3.94	6.01	7.13	9.19
1600	2.10	3.73	5.10	6.72	6400	3.76	5.58	6.44	8.26
1700	2.23	3.94	5.39	7.10	6600	3.56	5.11	5.67	7.22
1800	2.34	4.15	5.67	7.47	6800	3.32	4.57	4.80	6.06
1900	2.46	4.35	5.94	7.83	7000	3.05	3.98	3.84	4.77
2000	2.58	4.56	6.21	8.18	7200	2.75	3.31	2.79	3.36
2200	2.80	4.94	6.73	8.85	7400	2.42	2.60	1.64	1.82
2400	3.01	5.30	7.21	9.51	7600	2.05	1.82	0.39	0.14
2600	3.21	5.65	7.67	10.09	7800	1.65	0.95	.....	.....
2800	3 40	5.97	8.09	10.64	8000	1.21	.....	.....	.....
3000	3.58	6.25	8.47	11.14	8200	0.74	.....	.....	.....
3200	3.74	6.52	8.80	11.58	8400	0.23	.....	.....	.....

In all the above data it is assumed that the arc of contact of the belt is not less than 180 degrees.

If this arc is.....	90°	112½°	120°	135°	150°	157½°	180°
Divide H.P. given by	2.21	1.72	1.6	1.4	1.24	1.17	1.

* * *

As regards the efficiency of gasoline for power generation when consumed in an internal combustion engine, or when burned under a boiler to generate steam, it is found to be about as 2 to 1 in favor of the internal combustion type.

NEW SHOPS OF THE WESTERN ELECTRIC CO.

Fig. 1. Water Tower.

The new Hawthorne (Ill.) shops of the Western Electric Co. comprise a group of model buildings for the manufacture of direct and alternating current motors and generators, and of rubber in the various forms required for electrical work. The design, appointments and equipment of the plant are all that experience and an extended study of the existing conditions could dictate, and the result is a manufactory complete in every detail, with its own sources of supply for heat, power, light, water, gas, etc.

In Fig. 2 is the foundry, which is a brick and steel structure, having a Luci Viti tile roof. The building is 400 feet long, divided into three bays. Over the center, or main bay, which is for large work, are located two thirty-ton cranes. The West bay is 75 feet wide and has a low roof; it being used exclusively for bench work. The East bay which is 30 feet wide, is divided into sections containing the cupolas, storage bins and core ovens.

The machine shop, lying at right angles to the foundry, is 860 feet long and 150 feet wide, and is of the same type of construction, except the roof, which is of steel and tarred roof construction. There are three bays; the center one, 76 feet wide, is devoted to the manufacture of generators and motors. The north bay, 48 feet wide, contains such machine tools as are required in the manufacture of small types of machines. In this bay is located the testing department. The south bay has two floors; the upper one being devoted to the manufacture of small field coils and the winding of small armatures. It also contains the small detail and finishing departments. The lower floor contains the commutator and large detail departments, stock rooms and general shop offices, including that of the shipping department. The lighting is obtained from overhead skylights and side windows. Over the main bay are located two 30-ton, and over the north bay six 20-ton cranes. The entire plant is equipped with a system of industrial railways.

On the opposite side of the track from the shop and foundry is the cable plant, which covers a very large area and is now being increased to still further extent. The buildings of this department are of one story, with saw-tooth roof.

The power plant comprises an engine and boiler room, with space for two batteries of eight boilers, each. One battery of Aultman and Taylor boilers has been installed, with chain grate stokers and Greene fuel economizers.

The main railroad tracks dividing the company's property afford an easy means of handling the coal as they are of such a height that cars may be switched by means of an elevated spur track into the storage bins located above the boiler room. These bins are of 1,000 tons capacity and are so designed that the coal may be discharged through spouts into a hopper scale for each division of boilers. This scale is mounted on a track, so as to take the coal from any part of the bin and deliver it to any one of the stokers. The ash is discharged at the end of a chain grate stoker into a bin of 1½ ton capacity located below each boiler. From these bins the ash may be delivered into gondola cars and taken by means of a depressed railroad track to various places about the plant where filling may be required.

Fig. 2. Foundry of the Western Electric Co.

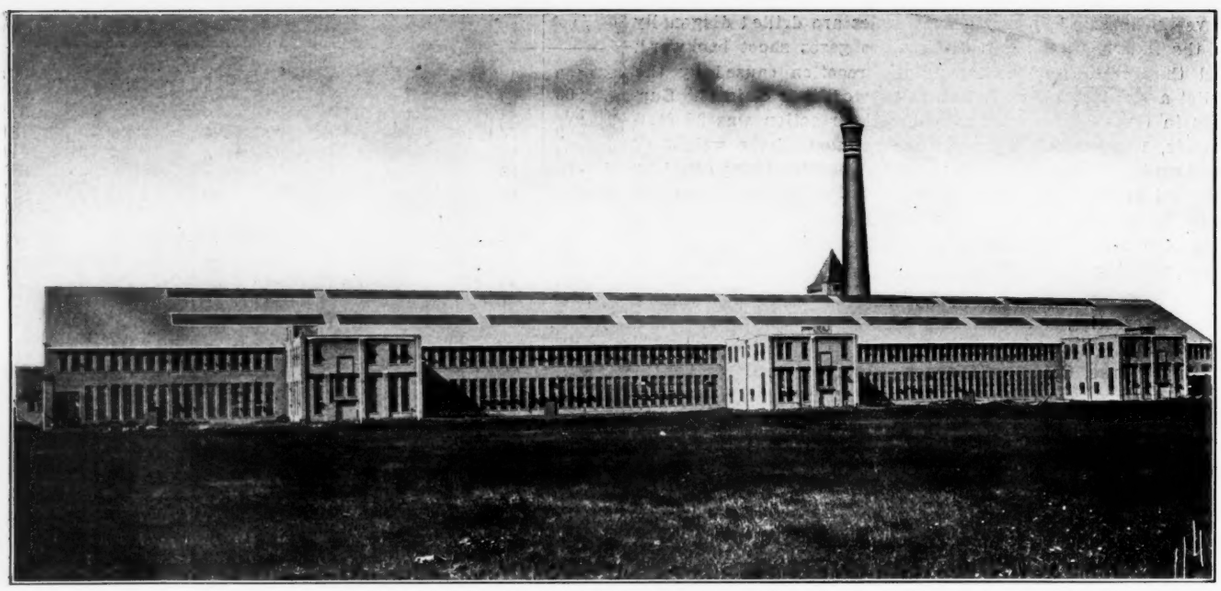


Fig. 3. General View of Machine Shop.

The continued uncertainty of the coal supply, due to strikes and other conditions beyond the control of the manufacturer, has led to a careful consideration of the problem of coal storage. The Western Electric Co., after investigating the question, decided to follow the practice adopted by the British Admiralty. Two storage bins, one of 4,000 and the other of 10,000 tons capacity, both located below the normal ground level, have been constructed into which coal may be dumped from cars and taken out by means of a locomotive crane fitted

with a grab bucket. Carefully executed tests in Europe show that nearly 30 per cent of the heating value of coal is lost in six weeks when stored exposed to the air. By keeping the bins flooded, the company expects to reduce the losses of the coal to approximately two per cent of its heating value after six months to a year storage. By this system of storage there is provided sufficient coal to operate the plant under normal winter conditions for four months.

The engine room has four units of 300, 500, 1,000 and 1,200 K. W. capacities. The largest generator is driven by a vertical compound Rice and Sargent engine; the 1,000 K. W. generator by a vertical compound Filer and Stowell engine; and the two smaller generators by horizontal cross-compound engines. Three Wheeler surface condensers are installed.

Water for the power plant comes from an adjacent reservoir. A water tower of artistic design has been built for supplying the hydrants and sprinklers, and the lavatories. The reservoir and water tanks receive their supply from the city systems. Drinking water is obtained from a well.

Compressed air is supplied to the whole plant from a compressor in the engine room, for pneumatic tools, for blowing out cables, operating molding machines, etc.

Uncarbureted water gas, used in the heating and baking ovens and annealing furnaces about the plant, is furnished by two generators, each with a capacity of 25,000 cubic feet per hour. The gas is stored in a tank of 100,000 cubic feet capacity, and has a heating value of approximately 300 B. T. U. It is made from a good grade of furnace coke, and costs, exclusive of fixed charges, such an amount as to compete favorably with 12,000 B. T. U. coal at $2.80 per ton. It has approximately 50 per cent of the heating value of, and costs 50 per cent less than city gas.

A second tank is being constructed which will enable the company to run one gas generator during the entire twenty-four hours with pronounced economy over present conditions, which require both generators to work at certain times of the day.

All buildings are heated by direct radiation except the foundry and machine shops, the foundry being equipped with a hot-air system, while the machine shop has a combined direct radiation and hot air system. The heating coils are supplied with steam under the Warren-Webster system. In the wintertime one or more engines are operated non-condensing, the steam circulating under slightly less than atmospheric pressure. The efficiency of this arrangement is apparent when it is considered that during last winter no steam was required for heating other than that furnished by the exhaust of the engine.

A feature of interest is a crematory for the shavings and chips from the carpenter shops. It contains a boiler and Dutch oven especially for the purpose. The electrical equipment of the plant comprises Western Electric apparatus and the tools are electrically driven throughout.

Fig. 4. Interior of Machine Shop.

The various buildings are connected with the power house by a system of well lighted and ventilated tunnels in which are located the telephone, lighting and power cables, and pipes for the drinking, city and house water, compressed air, live and exhaust steam, vacuum and trap returns, roof drain and hydraulic elevators. These tunnels have a uniform height of 7 feet, and vary in width from 4 to 10 feet.

Connecting with the tunnel leading to the Machine Shop, is a system of concrete trenches surrounding the iron plates of the testing floor. Within these trenches are cables leading into junction points at which are available for testing purposes all voltages from 30 to 600 volts, both direct current and alternating current of 25 and 60 cycles.

Careful attention has been given to the fire hazard. An engineer trained in the inspection of manufacturing properties, devotes his entire time to the fire protection devices and to the safeguarding of all of the processes of manufacture. In

general, the different departments have one-story buildings by themselves, each far enough removed from its neighbor to eliminate the danger of fire spreading. Large areas are divided by heavy fire walls with double tin-clad doors at the openings.

The walls are of brick, with wire-glass windows at exposed points, and the floors of concrete or concrete with wooden surface. The roofs are tile on structural steel. With the exception of three buildings, the property is protected throughout by automatic sprinklers. The three exceptions are the foundry, forge shop and main body of the machine shop, in which there is absolutely no combustible material.

An interesting feature is a circle of sprinkler pipes with heads on the sides of each steel post supporting the roof in the machine shop. These heads are about 15 feet above the floor and are designed to protect these posts from danger that may arise from inflammable material gathering about their bases. The sprinkler system is supplied with water through an elaborate yard system of about 13,000 feet of 10- and 12-inch water pipe, the feed into each building being controlled by a gate with a post indicator so that the supply may be regulated without entering the building, a valuable feature in time of fire.

Forty fire hydrants, each with three or four independent gates, are located about the property on the same yard mains that supply the sprinkler system and are so placed as to make possible the complete surrounding of any one building by fire streams. Each hydrant is protected by a wooden house in which are stored hose play pipes, axes, lanterns, etc. The amount of hose varies per hydrant from 200 to 500 feet, depending upon the length of the line that the particular hydrant is likely to be called upon to furnish. There is as well, 1,000 feet of hose on the carts in the fire station. This makes a total of about 6,000 feet of 2½-inch fire hose.

In the fire house adjoining the tower containing the sprinkler tanks are two 1,500 gallon Underwriters' fire pumps ready for instant duty. These pumps are each capable of throwing six good fire streams and draw their supply from the large reservoir, pumping into the yard system, thus supplying both the sprinklers and the hydrants as needed.

There is available in the tower for the sprinkler system and hydrants—213,000 gallons of water, and as soon as the pumps are placed in operation an additional supply of 3,000 gallons per minute so long as the 5,000,000 gallon reservoir holds out. Running both pumps full capacity the reservoir will last for 27 hours.

All of the buildings are liberally equipped with water and sand pails for fire use, with chemical extinguishers and with small hose connected to the sprinkler system. There is about 4,500 feet of this small hose distributed throughout the different buildings.

This elaborate and expensive system of fire protection would be of small value if trained men were not available for instant fire duty; therefore, the company maintains a fire brigade among its employees.

An ex-member of the Protective Department from the city of Chicago is the chief of the fire department, and devotes his time solely to the apparatus and the training of the brigade. Under him, during the day, are sixteen men employed in the department near the fire house who respond to all alarms. These men are picked for this special duty and are given extra compensation, including pay for drills as well as for fire service. At least twice a week a trial alarm is rung in, the department drilled with the use of the different apparatus, and familiarized with the surroundings and conditions that they would be likely to meet in time of fire. At night nine watchmen with a fire captain form a brigade, there being at least five of them at all hours of the night in the pump house where beds are provided for sleeping accommodations.

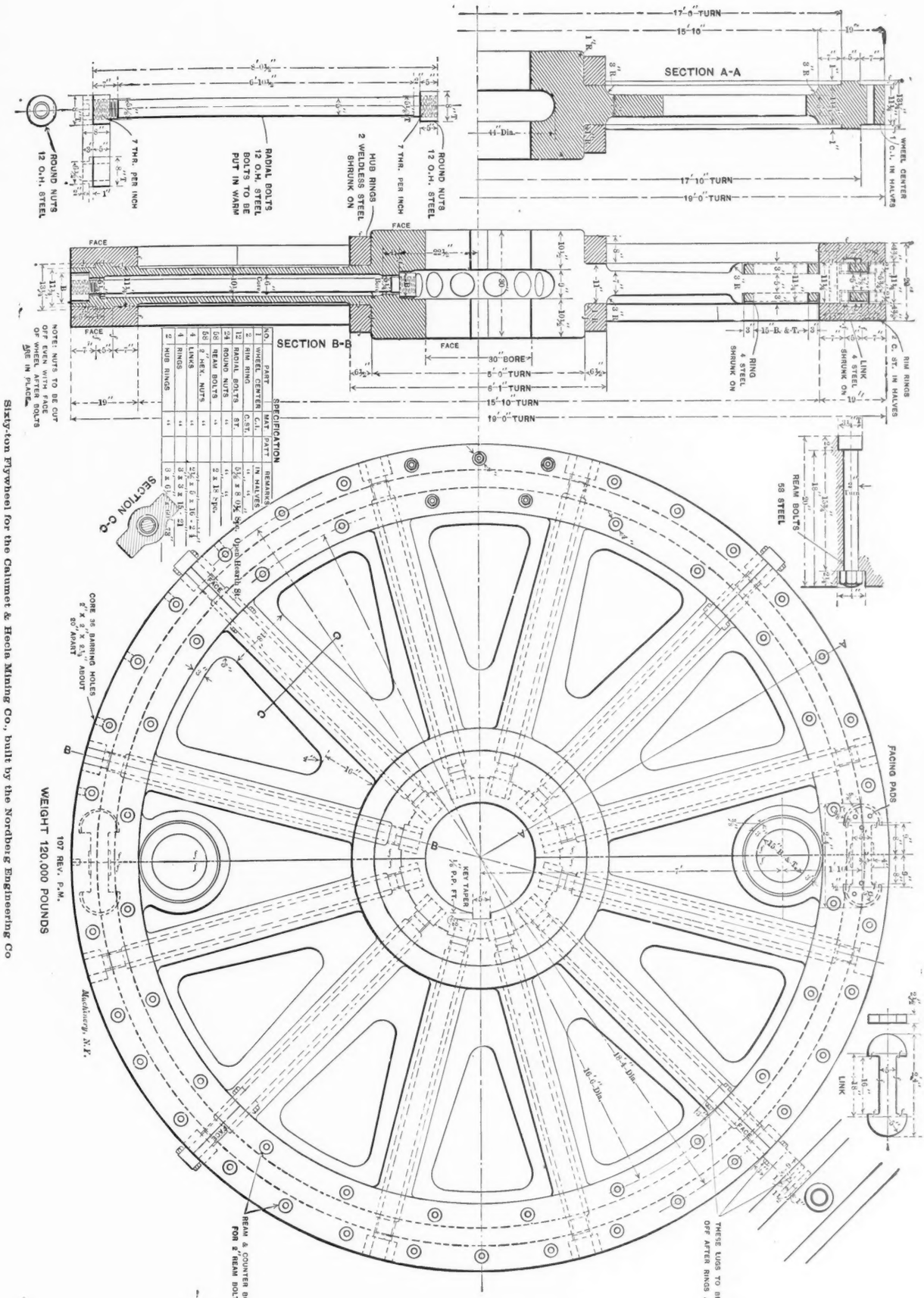
A system of forty-seven fire boxes has been installed, permitting prompt notification to the fire house, the members of the fire brigade, the engineer in charge of the fire pumps and the shop superintendent, so that immediately all of the trained force may be on duty. The average time taken to get sixteen men and two streams of water at any point of the property is less than two minutes after turning in the alarm.

SIXTY-TON FLYWHEEL.

A 19-foot flywheel of special and interesting construction, which was built about one year ago by the Nordberg Engineering Co., Milwaukee, Wis., for a mine pumping engine operated by the Calumet & Hecla Mining Co., is shown in detail in the full page cut herewith. The wheel weighs 120,000 pounds and is designed to run at 107 revolutions per minute which means a peripheral speed of nearly 6,400 feet per minute. A reasonable factor of safety for this speed requires a construction considerably stronger than possible with the usual plain form of cast iron flywheel. The nominal safe speed limit for cast iron wheels is put at about 5,000 feet per minute but the jump to 6,400 feet means that the bursting stress is increased in the ratio of 2.5 to 4.10. It might be argued that reversing rolling-mill flywheels which are subjected to tremendous shocks by reason of constant reversals are made of plain cast iron construction and stand up to the work with very few failures, but this argument would be made without taking into consideration the great increase of centrifugal force incident to increasing the speed even as little as 10 per cent. Between the reversing rolling-mill flywheel running at say 4,000 feet per minute and this wheel running at 6,400 feet per minute the centrifugal stress, which increases as the square of the velocity, as is evident in the formula for centrifugal force, $F = 0.000341\ W R N^2$, changes the factor of disruptive stress in the ratio of 1.6 to 4.10. The stress on the reversal does not directly affect the integrity of the rim, but does throw a heavy bending stress on the spokes, hence the part of a reversing flywheel which is most affected at reversing is the spokes and not the rim. Therefore, the comparison between the plain reversing mill flywheel and the reinforced wheel forming the subject of this description should be made on the basis of speed alone and not with reference to the effect of reversal.

The Calumet & Hecla wheel is made up of two cast iron segments forming the wheel center. These segments are held together by two steel shrink rings on the hub, four shrink rings under the rim and two steel rim rings made in halves and secured to the sides of the cast iron rim of the wheel center by 58 bolts 2 inches diameter and 18 inches long. In addition the halves of the wheel center are bound together by four T-head steel links set in the pockets underneath the rim rings and shrunk on in the usual manner. The spokes are cast hollow and 12 open-hearth steel bolts 5 inches diameter are set radially therein, being secured at the ends by round nuts fitting in countersunk seats. These bolts are warmed up before being put in place and the nuts are screwed up tightly before cooling, thus getting a heavy compression effect on the spokes due to the contraction of the bolts, the intention of the designer being to relieve the cast iron parts of all tensional strain due to centrifugal force. The spokes of the cast iron wheel center have an open space between each pair save at the junction of the halves where the web is made solid, having a thickness of 7 inches next the hub. A boss is cast on each side under the rim in which an annular seat is machined with a boring bar for four steel shrink rings which bind the two halves together. The rim rings are steel castings and are provided with temporary lugs for bolting together for the boring and facing operations in the boring mill. After being bolted to the sides of the cast iron center the lugs are chipped off, leaving a smooth surface.

The blueprint from which our cut was made was reproduced with little change and it will be noted that complete information regarding the construction of the wheel is given thereon. For this reason we would commend it as an excellent example of what a shop drawing should be. The drawing, notes and tabular specifications, together with the table of weights (which latter is not shown on the cut), gave practically everything necessary for the construction, leaving nothing, so far as we are able to see, that would need explanation on the part of the drafting department. It also gave the editors about all the data necessary for the writing of this description. The blueprint is of a size convenient for use in the shop, being drawn to a scale of ¾ inch per foot; this is large enough to show all the parts and dimensions clearly. The blueprint measures 17⅜ x 22¼ inches within the border lines.


SECTION A-A
SECTION B-B
SECTION C-C
17'-8" TURN
15'-10"
17'-10" TURN
19'-0" TURN
30" BORE
5'-0" TURN
6'-1" TURN
15'-10" TURN
19'-0" TURN
WHEEL CENTER C.I. IN HALVES
RIM RINGS CAST STEEL IN HALVES
LINK 4 STEEL SHRUNK ON
RING 4 STEEL SHRUNK ON
HUB RINGS 2 WELDLESS STEEL SHRUNK ON
RADIAL BOLTS 12 O.H. STEEL BOLTS TO BE PUT IN WARM
ROUND NUTS 12 O.H. STEEL
7 THR. PER INCH
REAM BOLTS 58 STEEL
FACING PADS
KEY TAPER ½ P.P. FT.
CORE 36 BARRING HOLES 8" X 8" X 8½" APART ABOUT
107 REV. P.M.
WEIGHT 120,000 POUNDS
REAM & COUNTER BORE FOR 2" REAM BOLTS
THESE LUGS TO BE CHIPPED OFF AFTER RINGS ARE FACED
LINK
Machinery, N.Y.

NO.	PART	SPECIFICATION MAT'L	PATT	REMARKS
2	WHEEL CENTER	C.I.		IN HALVES
12	RIM RINGS	CAST STEEL		
24	RADIAL BOLTS	ST'L		
24	ROUND NUTS	"		
58	REAM BOLTS	"		
58	2 HEX. NUTS	"		
4	LINKS	"		
4	RINGS	"		
2	HUB RINGS	"		

NOTE: NUTS TO BE CUT OFF WHEN RIMS ARE FACED AFTER BOLTS ARE IN PLACE.

Sixty-ton Flywheel for the Calumet & Hecla Mining Co., built by the Nordberg Engineering Co

EXPERIENCES WITH STEAM TURBINES.

In a paper before the Iowa Electrical Association, Mr. C. E. Stanton gives the results of his operative experience with Curtis four-stage 500-K.W. turbines. The chief difficulties have been in connection with the water supply for the step bearings, the gravity oil supply for lubrication, and the occasional sticking of nozzle valves. All the water for the step bearings in the plant under observation passes through a strainer after leaving the pumps, to remove particles that might clog up the passages of the step bearings or injure the latter. The pumps for the service have fibrous packing and if this is left until it loses its elasticity and becomes soft, small particles find their way into the strainer and soon choke the supply of water to the step bearings. Dirt or particles of packing, when once in the system, may find their way into the strainers, even after many days or weeks, and the strainers must therefore be cleaned at intervals of twenty-four hours.

The hydraulic accumulator for the step bearing system, if allowed to remain in one position for a considerable period of time, was found to rust fast and not drop, even if all the pressure was removed from the steam, thus defeating the object for which the accumulator is intended. It therefore must be tested frequently by allowing the ram to drop slowly and then return to its former position, a test that was made each day. One other precaution that should be taken with accumulators for this work is to have some kind of signal, usually a steam whistle, which will blow if the accumulator starts to come down, thus notifying the engineer of the failure of the oil supply.

In the 500-K.W. turbines there are eight main nozzle valves, each with its individual pilot valve, which is electrically controlled. On any load within the rated capacity of the turbine, running condensing, five valves are all that open, leaving three valves which might not open for days at a time. If these are left long, they will corrode and stick and if a heavy overload should come might not open at all—or if they did open they might remain in this position. To obviate these troubles all valves are opened and closed several times each day when starting the turbines. Some difficulty was experienced in securing suitable packing for the main nozzle valves which would stand a high degree of superheat. Metallic packing was not successful and asbestos ring packing is now employed, which is satisfactory, except that the valve stems must be repacked more frequently than would be the case if metallic packing could be used.

The difficulty in lubrication arose through an air lock formed in the gravity oil tank, allowing air to come into the oil feeder pipe line and interfere with the flow of the oil. This would cause an intermittent flow of oil at times, but the trouble was remedied by venting the top of the tank. Attention is called by Mr. Stanton to the necessity, when regulating the turbines, for having the plates of the step bearing lined perfectly and free to adjust themselves and also of the same diameter to avoid the formation of a fin around the outer periphery of either of the plates. It was found also that the steady bearing which is directly above the step bearing should be thoroughly cleaned and examined for any rough spots before being put in place. This bearing consists of a tapered sleeve which fits in a corresponding tapered hole in the base of the turbine. If it does not seat perfectly, owing to dirt or rough spots, it will work loose and cannot be held in place. In all cases where trouble has been had with this bearing it was found to be due to dirt, bruises or metal chips. Two kinds of middle and top bearings were tried. First both of these were solid shells, held rigidly in place; but at present bearings of the spring type are employed and these springs have had to be renewed several times.

The difficulties experienced in the operation of these turbines have been very slight, as indicated by the foregoing, and have had to do quite as much with auxiliaries as with the turbines themselves. Mr. Stanton concludes his paper with the statement that the turbine has upset many of the hard and fast principles of the Corliss engine builder and is doubtless here to stay. The economy and efficiency of the steam turbine are so pronounced that this type of prime mover is being universally adopted in modern plants for the generation of electrical energy. He said the close regulation of the turbines was a surprise to him and that it is possible to operate the electrical railway and the power and lighting circuits on one set of buss bars without experiencing any trouble with the regulation on other lines.

* * *

SEVENTY YEARS AGO.

At a recent meeting of the New England Cotton Manufacturers' Association, Stephen A. Knight, a veteran in the cotton industry, gave some reminiscences of his early life, which cast an unpleasant light upon the conditions that existed 70 years ago. It almost shocks us, for example, to find that only 70 years ago the working day in some of the mills, at least, was fourteen hours, and that a young boy received only 42 cents a week for his services. We all know that in these days conditions are none too good in textile centers; but they are infinitely better than they used to be. Mr. Knight relates:

In 1835 I began my labors in a cotton mill as bobbin boy, or, as it was termed in those days, back boy. The mill was in the state of Rhode Island, being in the town of Goventry. It was owned by a man who was at one time Governor of Rhode Island, a man who was a progressive and intelligent manufacturer. His mill was "up-to-date" and among the most successful in the country at that time.

My work was to put in the roving on a pair of mules containing 256 spindles. It required three hands—a spinner, a fore side piecer and a back boy—to keep that pair of mules in operation. The spinner who worked alongside with me died about two years ago at the age of one hundred and three years, an evidence that all do not die young who spend their early life in a cotton mill. I am hoping to go him one better.

The running time for that mill, on an average, was about fourteen hours per day. In the summer months we went in as early as we could see, worked about an hour and a half, and then had a half hour for breakfast. At twelve o'colck we had another half hour for dinner, and then we worked until the stars were out.

From September 20 until March 20, we went to work at five o'clock in the morning and came out at eight o'clock at night, having the same hours for meals as in the summer time.

The proprietor of that mill was accustomed to make a contract with his help on the first day of April, for the coming year. That contract was supposed to be sacred, and it was looked upon as a disgrace to ignore the contracts thus made. On one of these anniversaries, a mother with several children suggested to the proprietor that the pay seemed small. The proprietor replied, "You get enough to eat, don't you?" The mother said, "Just enough to keep the wolf from the door." He then remarked, "You get enough clothes to wear, don't you?" to which she answered, "Barely enough to cover our nakedness." "Well," said the proprietor, "we want the rest." And that proprietor, on the whole, was as kind and considerate to his help as was any other manufacturer at that time.

The opportunities for an education among the factory help were exceedingly limited, as you can well see, both from the standpoint of time and from the standpoint of money.

The power of the mill was taken from the north branch of the Pawtuxet river on to a breast wheel, connected with segment gears, to an upright shaft by a pinion gear. The wheel was in about the center of the mill and occupied a space on the first floor, about twenty feet long and about three-quarters of the width of the mill, full height of the first story which was the weaving room. The upright, as well as most of the shafting in the mill, was square, turned only where the bearings came. A main line ran from the upright each way and was driven by a crown wheel and bevel pinion.

The upright ran up through the entire mill. The driving pulleys, or, more properly speaking, the drums were wood with iron clamps to connect them to the shafting, made tight and trued up with iron wedges. The belting was made by the overseer in each room from sides of leather just as it came from the tannery.

SURVEYING WITHOUT INSTRUMENTS.

A. L. DE LEEUW.

This subject may seem somewhat out of place in a magazine which deals almost exclusively with machinery, but it is really not more so than a description of shop buildings. It happens quite frequently that the shop man has to do some surveying on a small scale, in order to locate new buildings, or an industrial track, or, perhaps, for some other purpose. Surveyor's instruments are not always at hand, and even if they are the shop man does not always know how to make use of them. I, myself, have had some use of the following kinks, and, although the result is not reliable to a sixty-fourth of an inch, such accuracy is not at all required in those cases where I would recommend the methods explained. By saying "surveying without instruments," I do not mean that no tools at all are required, but that the work can be done without the ordinary surveyor's instruments, and without knowing how to handle them. I propose to give some examples, and to leave it to the reader to find others, and to find his own solutions.

Problem 1.—To find the distance from a point, *A*, to another point, *P*, which is visible but inaccessible. (See Fig. 1.)

As in all other problems, it is supposed that a few stakes, plenty of light rope, and a tape line are handy. Other instruments are not required.

Fig. 1 shows the proceedings. First drive a stake at *A*. Then place another one, *B*, in line with *A* and *P*. Measure the distance from *A* to *B*, by means of the tape line. Next, place another stake somewhere at *C*, and still another one somewhere at *E*, between *A* and *C*. Stretch the rope, *BC*, and move a stake along this rope, until it comes in line with *E* and *P*. This stake is marked *D* in the drawing. Measure the distances *AE*, *CE*, *CD*, *BD* and *AB*. These distances are called in the drawing *b*, *c*, *d*, *e* and *a*.

According to a well-known proposition:

$$AE \times CD \times PB = CE \times DB \times PA. \quad \text{(See Note 1.)}$$

$$bd\,(x - a) = cex.$$

$$bdx - abd = cex.$$

$$abd = (bd - ce)\,x.$$

$$x = \frac{abd}{bd - ce}.$$

Problem 2.—To find the distance between two points, *P* and *Q*; both visible but inaccessible. (See Fig. 2.)

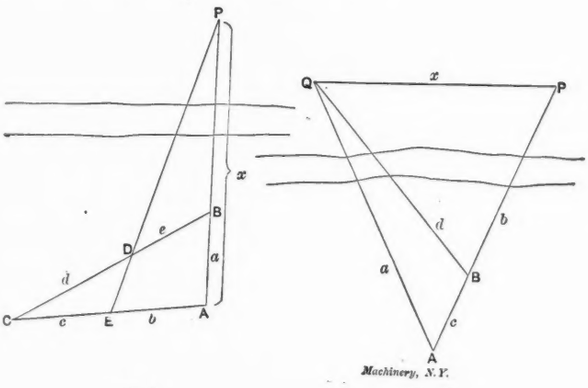


Fig. 1.

Fig. 2.

Select a point *A* and find the distances from this point to *P* and *Q*, according to the procedure of problem No. 1. Further, select a point *B*, in line with *A* and *P* (or *A* and *Q*, as may seem best). Then find the distance from *B* to the other point (*Q* in this case), also according to the proceeding of problem No. 1. The following lines are then known in the triangle *APQ*: *AB*, *BP*, *BQ* and *AQ*, which are called *c*, *b*, *d* and *a* in the drawing. In order to find the distance *PQ*, we apply a formula which is not nearly so well known as it should be, for it is a very handy one. This formula, or rather proposition, is that when a line *QB* is drawn from a point of a triangle to a point of the opposite side, then

$$QB^2 \times AP = PQ^2 \times AB + AQ^2 \times BP - AB \times PB \times AP.$$

(See Note 2.)

As the only unknown quantity in this case is the line *PQ*, it will be easy to find it by means of the foregoing formula.

Problem 3. To find the distance from a point, *A*, to another point, *P*, which is invisible from *A*. (See Fig. 3.)

It is assumed here that *P* is visible from some other point *B*, and that this point *B* is also accessible. Measure the distances *PB*, *PC*, *BC* and *AC*. It will be easily seen that this brings the problem back to the previous one, as *PC* is a line drawn in a triangle from an apex to a point of the opposite side.

Problem 4.—To find the distance from a point *A* to a point *P*, which is both invisible and inaccessible from the point *A*. (See Fig. 4.)

Select two points, *C* and *D*, from which *P* can be seen. Find the distances *PD* and *PC* according to problem No. 1, and measure the lines *AC*, *AD* and *CD* with the tape line. As all

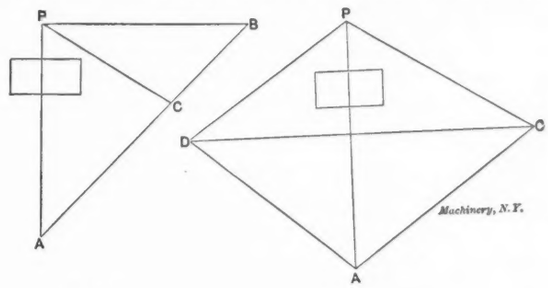


Fig. 3.

Fig. 4.

sides of triangles *CDP* and *CDA* are known, it is easy to find angles *PDC* and *ADC*. Adding these two angles gives angle *PDA*, and this, with the lines *PD* and *AD* gives us the necessary elements to figure line *AP*.

Problem 5.—To find the distance between two inaccessible points, *P* and *Q*, which are not visible at the same time from one point.

Select a point *A*, and find the distance from this point to both points *P* and *Q*, according to problem No. 4. Select also another point *B*, and do the same; and then measure the distance *AB*. As the drawing shows, the following lines are now known: *PA*, *PB*, *QA*, *QB* and *AB*.

In triangle *PBA*, find angle *PBA*. In triangle *QBA*, find angle *QBA*. The difference between these two angles is *PBQ*. This angle, with the two sides *PB* and *QB*, makes it possible to find *PQ* in triangle *PQB*.

Problem 6.—To draw a line from a given point *A*, perpendicular to the line between two visible but inaccessible points, *P* and *Q*. (See Fig. 6.)

First find the distances from the point *A* to both points *P* and *Q*. Then take an arbitrary point *B*, in line with *A* and *P*, and measure the distance *AB*. Now find a point *C* in line with *A* and *Q*, so that line *BC* will be parallel with *PQ*. For this purpose *AC* must be made of such a length that it is the fourth proportional to *AP*, *AB*, and *AQ*. A line should now be stretched between *B* and *C*. A line, drawn perpendicular to *BC*, will also be perpendicular to *PQ*. In order to draw this line, the point *D* must be located. It is well known that

$$AC^2 - AB^2 = CD^2 - BD^2.$$

This might be written thus:

$$AC^2 - AB^2 = (CD + BD) \times (CD - BD).$$

$$CD - BD = \frac{AC^2 - AB^2}{BC}$$

Knowing the sum and the difference between *CD* and *BD*, either can be found. The line going through *A* and *D* will be perpendicular to *PQ*.

It should be noted that this solution also shows how to draw a line going through a given point, and parallel with the line *PQ*, going through two visible but inaccessible points.

I used problem No. 1 at one time as the basis for a range finder, to be used by the military for field practice. It was given a trial, and proved quite successful. The apparatus consisted of an endless rope, to which three rings were attached at *A*, *B* and *C*, Fig. 7. When stretched, the rope assumed the shape of a right angle triangle; as the three parts

of the rope were 45, 60 and 75 yards respectively. Another ring was attached to the center of *BC*. A number of brass tags were hung from different points of *AC*. The mode of operating was as follows: Suppose it was desired to find the distance from *A* to *P*. Three men would take hold of the endless rope, by the rings at *A*, *B* and *C*. The first man would place himself in position at the point *A*. The second man would swing around until called to a halt by the first. This would happen when he was in line with *A* and *P*. The third man would then stretch the two remaining legs of the triangle. A stake or rod was held through the ring at *E*. The man who was to find the range would then take a gun, to which a small plumb bob was hung. He would place himself somewhere in the line *AC*, where he could sight with the gun over the points *D* and *P*. The plumb bob would drop over or near a tag, and he would take note of which tag it was. He would then put the gun down and read the tag. The tag gave him the distance from *A* to *P* in yards. The whole proceeding did not quite take a minute from the moment the rope was unfolded until the result was reached. The fact that four men were required was no objection in military field practice. Distances of 1,000 yards could be estimated with more than sufficient accuracy.

Notes.

Note 1.—The proposition used to solve problem No. 1 is known as the theorem of Ceva, and is about 2,300 years old. It forms the basis of an important chapter of geometry, but it is not often taught in schools and colleges. It has become a habit, confirmed by centuries, to teach geometry as it was taught in the days of Euclid. The continental countries of Europe have emancipated themselves in this respect; but England, and, to a very large extent, America, also is still bowing down before the propositions of Euclid. That his propositions are poorly arranged, a number of his demonstrations unnecessarily lengthy, and many of his definitions faulty and that, therefore, geometry misses its aim in the education of the young man or woman, namely, to develop keen and logical reasoning, seems to be of no importance. Euclid did it this way, and this is the way it must be done to the end of days. I believe that geometry is the only thing that has been standing still for more than 2,000 years in countries otherwise civilized. It is true that some schools follow the modified course of Legendre; but his system is

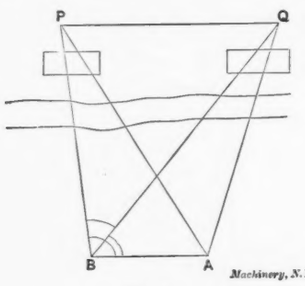


Fig. 5.

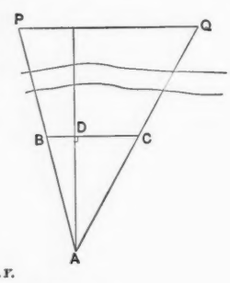


Fig. 6.

not better than that of Euclid. I do not wish to be understood as slighting the merits of either Euclid or Legendre. Either of the two was a very much better mathematician than I can ever hope to be. But they were pioneers; and we should not be satisfied with the work of pioneers several hundred or thousand years after they have died. I believe that this lack of progress, and also the lack of pure logic, are causes which make geometry unpopular, and which rob it of its educational value.

However, I am drifting away from my subject, which was supposed to be the demonstration of the theorem of Ceva. (See Fig. 8.)

ABC is a triangle, and *DEF* is a line intersecting the sides of the triangle, or their extensions. It should be demonstrated that

$$AF \times CE \times BD = AD \times BE \times CF.$$

In order to prove this, draw line *BG* parallel to *AC*. The triangles *DBG* and *DAF* are similar, and therefore,

$$DB : DA = GB : AF. \qquad (1)$$

The triangles *GBE* and *CFE* are also similar so that

$$GB : CF = BE : CE \qquad (2)$$

Multiplying equations (1) and (2) we find

$BD \times GB : DA \times CF = GB \times BE : AF \times CE$ or

$DB \times GB \times AF \times CE = DA \times CF \times GB \times BE$ or

$AF \times CE \times BD = AD \times BE \times CF$, which was to be demonstrated.

Note 2.—The proposition used for the solution of problem No. 2 is what is known as the theorem of Stewart. The most common way of demonstrating this proposition is by means of the theorem of Pythagoras.

If, in a triangle *ABC*, Fig. 9, a line is drawn from *C* to a point *D* of the line *AB* (or its extension) then

$$CD^2 \times AB = AC^2 \times BD + BC^2 \times AD - AD \times BD \times AB.$$

Draw *CE* perpendicular to *AB*. Applying the theorem of Pythagoras to triangle *ADC*, we find

$$CD^2 = AC^2 + AD^2 - 2AD \times AE.$$

Multiplying this expression by *BD*, we find

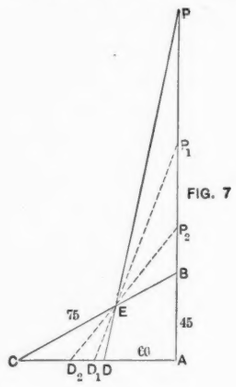


FIG. 7

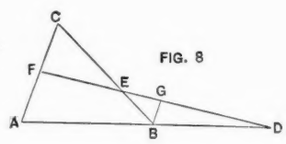


FIG. 8

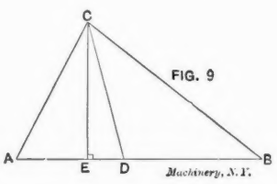


FIG. 9

$$CD^2 \times BD = AC^2 \times BD + AD^2 \times BD - 2AD \times BD \times AE. \qquad (1)$$

In triangle *BCD* we find:

$$CD^2 = BC^2 + BD^2 - 2BE \times BD.$$

Multiplying by *AD*, we find

$$CD^2 \times AD = BC^2 \times AD + BD^2 \times AD - 2BE \times BD \times AD. \qquad (2)$$

Adding expressions (1) and (2), we find

$CD^2\ (AD + BD) = AC^2 \times BD + BC^2 \times AD + (AD^2 \times BD + BD^2 \times AD) - 2AD \times BD \times (AE + BE) = CD^2 \times AB = AC^2 \times BD + BC^2 \times AD + AD \times BD \times AB - 2AD \times BD \times AB.$

$CD^2 \times AB = AC^2 \times BD + BC^2 \times AD - AD \times BD \times AB$, which was to be demonstrated.

* * *

Tantalum is one of the hardest metals known and up to within a few years ago it was not produced in any other but powder form. The Siemens & Halske Co. have succeeded in producing it commercially in sheets and bars, but it is so hard as to be unworkable with tools, even the diamond not being able to cut it except very slowly. This being the fact, it is remarkable that the production of the incandescent lamp, in which a filament of tantalum of considerable length is used instead of the carbon filament as is usual in the incandescent lamp, is possible. The ordinary method of drawing metals would not apply to tantalum, so that the production of the filament would seem to be an impossibility by ordinary metal-working processes. The filament is made by the squirting process, we understand, the same as the carbon filament of electric lamps is produced. The powdered tantalum is mixed with water and gum tragacanth, in which composition it is forced out into rods or threads as desired, and is afterwards heated to incandescence so that it fuses together into a solid wire. The gum tragacanth prevents the powdered tantalum packing into a solid mass under the press as it would do otherwise.

* * *

The contract for the construction of the immense terminal station of the Pennsylvania Railroad in New York City has been awarded to the Geo. A. Fuller Co., and is to be completed in four years at a cost of $25,000,000, exclusive of the site. It covers four blocks bounded by Seventh and Ninth Avenues and 31st and 33d Streets.

FREE ALCOHOL AND ITS EFFECT ON INDUSTRIAL CONDITIONS.

The bill making denaturized alcohol free from government tax has been passed by Congress and with the President's signature becomes a law January 1, 1907. The removal of the tax means a reduction of $1.10 per proof gallon, the proof gallon being 50 per cent pure alcohol. Hence on 90 per cent alcohol the government tax is $1.98 per gallon. It is expected with the government tax abated the cost to the consumer may be as low as 15 to 20 cents per gallon, 90 per cent proof. Pure ethyl or grain alcohol has a calorific value of about 28,500 B. T. U. per pound and a gallon of 90 per cent alcohol having a specific gravity of 0.833 contains nearly 200,000 B. T. U. or the equivalent in calorific value of nearly 10 pounds of crude petroleum.

It is unsafe to predict just what effect free alcohol will have on the industries of the United States but it is reasonably sure it will be of tremendous importance and a great boon to our people in general, judging by what has been done with it in Germany. Its use in large quantities would make it an important source of income to the agricultural class as grain alcohol may be derived from products which have been largely waste, as was pointed out by Mr. James Wilson, Secretary of Agriculture in his communication on the subject to the Congressional Committee on Ways and Means. But, the chief source will probably be potatoes and other root crops rich in starch which are easily and cheaply produced. It will be a double benefit to the farmer as it will not only give him a market for crops of this class but will also give him a fuel for internal combustion engines and for cooking that is cheaper than gasoline at the present price. This is especially important in the prairie regions of the West where fuel is high and where gasoline is now being largely used for both cooking and power purposes. It is also promised that alcohol will become an important competitor of kerosene in the matter of lighting, although the opponents of free alcohol claim that its advantage in this respect will be found disappointing. The alcohol lamp is not of the simple construction of the kerosene lamp but requires the use of a Welsbach mantle in order to make the same luminous. If this is the only serious difficulty it is not of great importance but is rather an advantage as it will result in the production of a light much richer in white rays than is possible to obtain with the kerosene lamp.

Regarding the use of alcohol in internal combustion engines it is claimed by those who have had experience that it can be used in gasoline engines with no change whatever in mechanism. Recent tests made by a member of the Automobile Club of America demonstrated this fact although they also demonstrated that a special carbureter is desirable inasmuch as it is necessary to first heat the alcohol in the carbureter to a considerable temperature for some time before it gives off sufficient vapor for operating the engine. One drawback to the use of pure alcohol in internal combustion engines is that it has a tendency to oxidize the interior working surfaces when left standing. For this reason a small percentage of gasoline mixed with the alcohol is advisable as it not only overcomes the oxidation but also increases the thermal efficiency of both products.

It is greatly to be hoped that free alcohol will fulfill the rosy future predicted, for it has one great advantage, economically considered, that is lacking in any other fuel except wood, and that is its perennial reproduction. It is comparatively easy to predict the ultimate exhaustion of any natural fuel, such as coal, petroleum and natural gas for none of these so far as we know are being manufactured by natural processes now but are simply deposits produced in a former geological age. Also the possible concentration of these natural resources in the hands of a few capitalists puts an enormous monopolistic power in the hands of a few, a condition that must inevitably be detrimental to the interests of the country. Not so with alcohol; it can be produced everywhere where grain or vegetables can be grown and its manufacture is so simple that even the ignorant moonshiners of Kentucky and Tennessee are able to produce it.

If free alcohol accomplishes only one thing and that is the substitution of grain alcohol for wood alcohol in the manufacture of shellac and other materials used by painters, pattern makers and others, it will have effected a great good. Many painters have been seriously poisoned and have even lost their eyesight by the use of shellac containing wood alcohol. The danger of its use has long been recognized by these trades and it is to a little band of painters in Massachusetts that we are indebted for this last strong movement which has finally resulted in giving us denaturized alcohol tax free. They interested Mr. Elihu Thompson, of the General Electric Co., in their movement, and his work before the Congressional Committee of Ways and Means had an important influence in gaining it the recognition that it deserved. Prof. Thompson's argument before this committee is of so much interest that we give it below in full.

ALCOHOL AS A MOTOR FUEL.

The importance of cheap alcohol as a fuel for internal combustion engines is not so generally realized as it should be. The increasing use of this type of engine, operated generally by gasoline as a fuel, is evident to everyone. By it there is furnished a power for all purposes which requires the minimum of attendance during the operation of the engine and no preparation before starting. As an engine for farm purposes the explosion type or internal combustion engine is ideal, and its general application to automobiles is already an evidence of its great convenience and effectiveness.

The use of gasoline as the fuel for such an engine is, however, subject to some disadvantages as compared with the employment of alcohol. In the first place the possible supply of gasoline is limited, and its increasing use must inevitably result in a very undesirable increase of price. It is a sort of by-product of the oil industry, and its price has already increased and will probably continue to increase. This is particularly true for the better or higher qualities. Gasoline is more volatile than alcohol, having a much lower boiling point, and is therefore proportionately more dangerous, especially in warm weather. The flame of burning gasoline is highly luminous and one which radiates heat rapidly, whereas the alcohol flame is a faint blue or an almost non-luminous flame, which does not radiate heat to any great extent. The consequence of this is that a mass of burning gasoline will radiate sufficient heat to set fire to things at a distance from it, while heat from burning alcohol goes upward, mostly in the hot gases which rise from the flame.

The case may be illustrated by comparing the flame of the burning pine log in an open fireplace with that of ordinary gas mixed with air in a fireplace. The flame from the burning pine log contains sufficient carbon to radiate the heat freely into the room from the fireplace, whereas the blue flame from the gas requires the assistance of a radiator heated thereby, generally known as a gas log, often composed of minerals, such as asbestos and the like, made red-hot by the blue or non-luminous gas flame. On this account alcohol is a safer fuel than gasoline, as the gasoline can set fire by pure radiation where alcohol would not. Gasoline, as well as kerosene, has the great disadvantage that it floats upon water and is distributed by water. It is a well-known fact that it is comparatively useless to attempt to extinguish burning gasoline or kerosene by water alone. The use of water may, in fact, be a positive disadvantage in floating the burning material over considerable places in spreading fire. Not so with alcohol, which mixes with water in all portions, and which is at once diluted and prevented from remaining combustible.

We have recently tested here at the works of the General Electric Co., in Lynn, a Deutz alcohol engine, a type of engine made in Germany especially for use with alcohol, and the results have been such as to prove without doubt the entire suitability of alcohol, if cheap enough, as a fuel for internal-combustion engines. This particular engine is to be sent to the island of Cuba and coupled to a dynamo for lighting. It will be operated with the cheap Cuban alcohol, which is, I am informed, sold there at about 12 to 15 cents per gallon. A few gallons of this alcohol were obtained and used in our tests here, and it was found to be a high-grade spirit containing 94 per cent alcohol by volume and 6 per cent of water.

or about 90 per cent alcohol by weight. While it is not methylated or denatured, there is no question that the behavior in the engine of denatured or methylated spirit would be identically the same as with the pure grain alcohol.

To obtain this sample of Cuban alcohol it was necessary that we pay an import tax of $4 per gallon, with other charges, which made the cost of the material used in testing enormous as compared with its actual value in Cuba, and I may here remark that, as in testing an engine of this kind a considerable quantity of alcohol will be used, manufacturers here in the United States would suffer a considerable disadvantage in building such engines as compared with those in a country where methylated spirit, untaxed, is obtainable. In fact, the cost of the material for testing the engines is probably a sufficiently strong deterrent just now to prevent the manufacture being taken up in the United States. The island of Cuba is, however, an excellent field for the use of such machinery, on account of the low cost of alcohol.

It may be mentioned here that our experiments developed the fact that alcohol is suitable as a motor fuel even when it contains as high a percentage as 15 per cent of water. Notwithstanding the fact that the heating value of alcohol, or the number of heat units contained, is much less than that in gasoline, it is found by actual experiment that a gallon of alcohol will develop substantially the same power in an internal-combustion engine as a gallon of gasoline. This is owing to the superior efficiency of operation when alcohol is used. Less of the heat is thrown away in waste gases and in the water jacket.

The mixture of alcohol vapor with air stands a much higher compression than does gasoline and air without premature explosion, and this is one of the main factors in giving a greater efficiency. It follows from this that, with alcohol at the same price as gasoline, the amount of power developed and the cost of the power will be relatively the same so far as fuel itself is concerned, but on account of the higher efficiency of the alcohol less cooling water is required, or a less percentage of the heat of combustion is communicated to the cylinder walls of the engine. The exhaust gases from the alcohol engine carry off less heat. They are cooler gases.

It is well known that the exhaust gases from a gasoline or kerosene engine are liable to be very objectionable on account of the odor. In our tests of the Deutz alcohol engine here there was absolutely no such objection with alcohol fuel, the exhaust gases being but slightly odorous, or nearly inodorous, and what odor there was was not of a disagreeable character. Our experiments with the burning of alcohol as a motor fuel also showed us that alcohol possesses a considerable tolerance as to the richness, or the reverse, of the mixture in the engine, and that even when there was considerable excess of alcohol for the air the exhaust was not disagreeable in odor, a condition which with either gasoline or kerosene leads to a smoky, badly smelling exhaust. The importance of a fuel which does not produce disagreeable exhaust gas is greatest in the case of stationary engines of considerable power, as in that case the exhaust is emitted in one locality and may become a source of nuisance. This has often been experienced with gasoline or kerosene engines and has tended greatly to limit their application, particularly in densely built-up sections.

There is just now the beginning of a large development in the application of the internal-combustion engine to the propulsion of railway cars on short lines as feeders to the main lines. In this case an ordinary passenger railway car is equipped with a power compartment at one end, in which power compartment there will be installed an engine of, say, 200 horse power of the internal-combustion or explosion type. The growth of such a system is liable to be hampered in the near future by the cost of gasoline as a fuel, and the difficulties of using kerosene are still quite considerable. Especially is the exhaust likely to be offensive. In this case alcohol, which could be produced in unlimited amount, could be substituted.

A large variety of agricultural products are easily capable of being converted into alcohol, and such products as are unmarketable, either from overabundance of crops or defective growth or damage are still available as sources. Hence each agricultural district would be able to supply itself with all the motor fuel needed, and at the same time produce for other districts. Inasmuch as alcohol can be stored in tanks for an indefinite period without change of its nature, any surplus production of alcohol can easily be taken care of. Speaking with a prominent beet-root sugar manufacturer, he gave it as his opinion that from the wastes of the beet-root sugar industry alcohol could be produced at a cost of about 10 to 12 cents per gallon. It is probably true that from other agricultural wastes, such as fruit parings, fruit partly decayed, surplus corn, etc., a cost equally low might be realized.

It is easily possible to convey alcohol by a pipe line, and its very limpidity or liquidity facilitates the process of pumping it through a line. It is reasonable to infer that, freed from tax, there is no possible substitute for this valuable fuel which could be supplied at such a low cost. It may be mentioned in conclusion that the efficiency—that is, the ratio of the conversion of the heat units contained in the fuel into power—is probably higher in the alcohol engine than in engines operated with any other combustible, and doubtless, on account of the comparative newness of the alcohol engines, there is still room for some improvement in this respect.

* * *

A HEATING PROBLEM.

The heating and ventilating of a church auditorium has always been an interesting problem, for there are conditions found, and difficulties to overcome, in an auditorium of this kind that do not occur in the ordinary building, such as large glass surfaces, which are the source of cold drafts, little floor space for placing radiators, and the fact that radiators near seats make those seats undesirable.

In the case of the Broadway Tabernacle, New York, there was a serious difficulty to contend with, namely, that under the auditorium there is a hall, which had to be left free of pipes and other objectionable features from an esthetic point of view; in other words, there is no cellar in which pipes and ducts could be placed. A space between the auditorium and the ceiling below was provided for this purpose. This space is about three feet deep, but as it is due to the depth of the girders that carry the floor its usefulness for placing pipes and ducts was limited, as can readily be understood.

After carefully considering all these points it was decided to use the blast system of heating, with mechanical exhaust and automatic temperature control for the auditorium, and direct radiators controlled by hand for the vestibules. The seating capacity of this auditorium is 1,500. The apparatus was designed to supply 25 cubic feet of air a minute per person to 1,600 persons, or a total of 40,000 cubic feet of air a minute.

It may be mentioned that in this case 25 cubic feet a minute per person was about the maximum amount of air that could be introduced without causing drafts and noise, and a large proportion of this air had to enter through top inlets. The entire use of bottom inlets would have been impossible without causing drafts, or considerably reducing the amount of air supplied. A three-quarter housed centrifugal fan, built by the B. F. Sturtevant Co., Boston, Mass., is used to supply the air. This fan has a blast wheel 9 feet in diameter by 4½ feet wide, and is driven by a direct connected motor. The fan is calculated to deliver 40,000 cubic feet of air a minute at 130 R. P. M.

* * *

In the manufacture of large gate valves much trouble has been experienced because of the liability of cracking the valve casting at the corners, especially under heavy pressures. For a long time it was attempted to correct this trouble by strengthening the castings at the corners. But after some costly experiments in this direction and after analyzing the matter it was concluded that the trouble was not due to lack of strength in the corners of the casting so much as to lack of stiffness in the sides, which, being unsupported, deflected outward under the water pressure and thus broke the castings at the corners because of the great leverage effect. This fact having become known, the obvious thing to do was to stiffen the side walls in the center, so that they would have the same characteristics as a stiff girder and thus be able to resist the pressure with small deflection. This obviated the difficulty.

SOME PROGRESS IN SIMPLE PRESS WORK.

H. J. BACHMANN.

In the phenomenally rapid progress made during the last decade in the press working of sheet metals by the introduction of compound, combination, sub-press, and gang dies, automatic roller and dial feeds, the simpler operations on the power press, instead of becoming subject to similar improvement, have been sadly neglected.

It is of these simple things, the basic elements of the art, that I wish to speak of in this article. Although the discussion applies principally to a single representative line of presses extensively used in this country, viz: Bliss, Nos. 19, 20 and 21, still the suggestions brought forward may be applied with slight modifications to any make of upright power press on the market to-day.

It is not so generally known as it should be that the ability to incline a press adds materially to its productive capacity. This advantage is almost doubled when the same belt may be used in both positions, permitting the change to be readily made without undue loss of time. I have, during my somewhat limited experience in this line, made it a rule to incline the press on all operations except "push through" jobs, that is, on all work which does not drop through the bed of the press. It is then simply necessary to feed the work to the dies, allowing it to drop out by gravity. To permit the use of the same belt for both positions, the press should be so placed on the floor that the center of the shaft when in its inclined position is the same distance from the line shaft as it is when the press is upright.

While there are many diemakers who advocate the use of a separate cast iron bolster for each die, I have been converted to bolsters made of cast steel which are largely used by Western shops. There are two made for each press, one for cutting dies and one for bending and forming dies, the construction of compound and combination dies remaining unchanged. By this system the separate dies are interchangeable on any press; they occupy less space on the shelves of the tool room, and inasmuch as all strippers and gages are fastened directly to the die instead of to the bolster, they never become lost when changing from one job to another. In this connection I wish to impress upon diemakers the desirability of using standard hex-head cap screws to hold down strippers, gages, etc. The strippers on any die may then be removed to facilitate correct setting of the die, and then replaced in position—something impossible on slotted head screws except by using an angle screw-driver.

There is little room for improvement in the cast-iron punch-holder. I can only suggest the use of solid piercing punches in place of the drill-rod surrounded by a soft steel sleeve riveted to a punch pad. I try wherever possible to do away with this old-fashioned soft steel punch-pad and let the punches into their holders either by turning a round shank on them or dovetailing them into the cast iron in the same manner as the die.

In planing up the die-blank it is well to remember to take a very slight cut from the bottom and a cut about twice as deep from the top. This removes the decarbonized surface from the cutting face where it needs most to be done, but leaves it on the bottom where the die may remain soft. Where there is

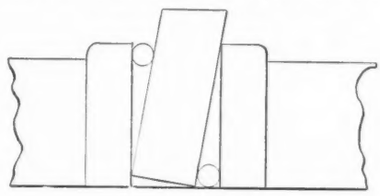


Fig. 1.

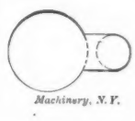
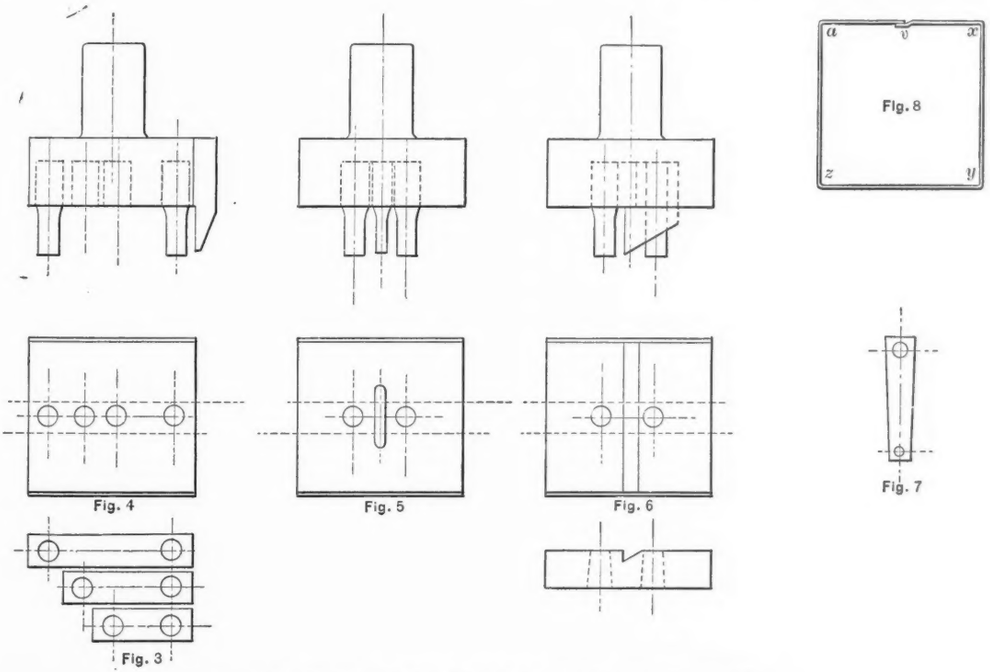


Fig. 2.

a scarcity of 10 degree parallels, two pieces of drill rod between the jaws of the vise may be arranged to give the correct angle. Quarter inch drill rod is the size to use when the jaws are 1 9-16 inch high as shown in Fig. 1. Where intricate shapes must be drilled out with small drills the holes may be laid out a trifle close together and the end of an old drill of the same size stuck into the first hole drilled. This will prevent the drill from running too far into the previously drilled hole and by proceeding in this manner all around the outline the core to be removed will drop out without the use of chisel or drift. The amount of draft on some blanking dies which are combinations of drilled holes, as, for instance, the shape in Fig. 2, may be infallibly indicated by reaming these holes from the back of the die with Stubs broaches as though they were simple piercing dies.



Steps in the Evolution of Press Tools for Making Copper Connectors.

Where extreme accuracy is essential, or a die is too large to be made of a single forging, the use of sectional dies becomes imperative. While the first cost of a well-made die of this kind is higher than that of a solid die still the ease of repair and uniformity of production of this type of die make it a winner in the long run.

The above conclusions may seem somewhat radical to some of the older men of the craft but they are not without foundation as some of your recent articles by Mr. Lucas will show. I am afraid there is a lack of initiative among the diemakers

of to-day. They go on making the same old thing in the same old way for the simple reason that they have never seen it done differently and find it impossible to take the responsibility of experimenting on a new idea.

The dies shown in the illustrations serve to emphasize the main features of this discussion. Fig. 4 shows a die as originally made for the three copper connectors shown in Fig. 3. It is a plain cutting-off die having the different holes placed in the die at the proper center distances apart. By means of a suitable adjustable gage and by placing one of the piercing punches in its proper position in the punch-holder, the three different sizes of connectors shown in Fig. 3 may be produced. However, during the process of improvement of the device on which these connectors were used, it became necessary to change the center distances between the holes and also to produce three longer ones. The die shown in Fig. 5 was at first considered adequate, but on account of the quantity required the scrap produced by the cutting punch was considered objectionable. Leaving the piercing punches in the same position, the shape of the cutting off punch was changed as shown in Fig. 6 and a corresponding "V" groove planed in the die. In connection with stripper and gage (not shown) this die allows the production of an indefinite number of connectors of different center distances.

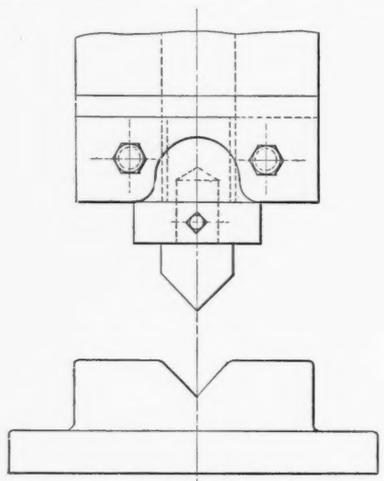


Fig. 10
Die for Corner of Sheet Iron Box.

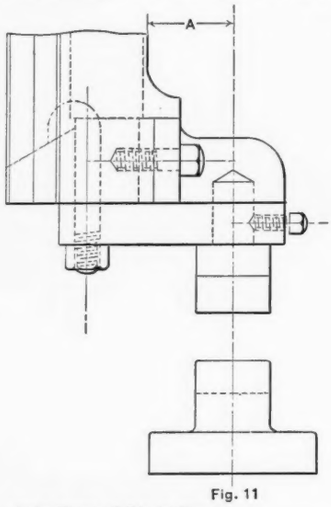


Fig. 11
Side View of Die in Fig. 10.

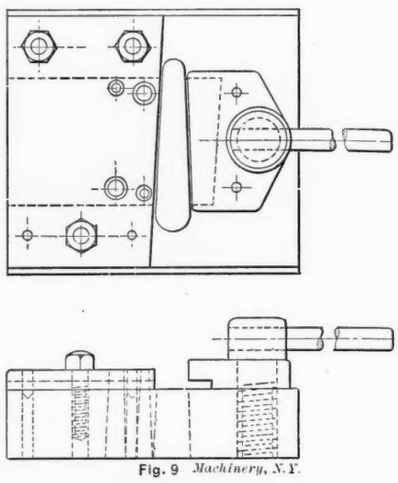


Fig. 9 *Machinery, N.Y.*
A Die for Punching without Waste the Pieces shown in Fig. 7.

The die shown in Fig. 8 impressed upon me the fact that the slitting shear is a valuable auxiliary to any press. The metal for the production of the copper segment ⅛ inch thick shown in Fig. 7 ordinarily would be cut a little wider than the length of blank so as to allow the punch to cut all around. But in all cases where two sides of a blank are parallel, the stock may be cut the exact width of the parallel portion of the blank in the slitting shear, and then they may be punched and cut off two at each stroke of the press as shown by the sketch of the die in Fig. 8. There is one inherent drawback to this form of die and that is the tendency of the punch to lift up the end blank while cutting it off and produce a badly bevelled edge. But if this portion of the strip is securely held down by the clamping device on the die as shown, the punch will have the same effect on both sides of the blank, cutting it off squarely. The gage and stripper held down by the cap-screws can be made a better fit on the stock than ordinarily because it is not necessary to lift it up past a stop pin fastened to the die to enable the operator to feed the strip. By inclining the press, allowing one blank to slide out when released by the clamp, and letting the punched one drop through, two complete blanks are produced at each stroke of the press with almost no scrap.

The extension punch and die in Figs. 10 and 11, which I have seen in various forms but never in print, is quite useful on work which is commonly beyond the scope of the press, such as the sheet iron box shown in Fig. 9. This forms the sides of a slate bottomed switch cabinet used on the old Manhattan Railway cars when they were equipped with electricity. The operations on this box included the bending of the 2 by ⅛ inch strap iron in four places, forming the lap joint, and riveting same. The sketch shows the punch and die (without necessary stops and gages) in position for bending the corners. The front clamping plate is removed from the ram and the cast steel extension bolted in its place with the same bolts. The large hook bolt extending into the hole in the ram and drawn up by the nut outside, is required to support the extension during the strain of bending. To allow the stock to clear the front of the press when bent into shape the distance "A" on Fig. 11 should be a little more than half the width of the strap iron to be bent, and to avoid fouling the flywheel corner, *x* on Fig. 9 should be the first one bent after the lap has been formed, and then, in rotation, corners *y*, *z* and *a*. When running the press at its accustomed speed on this job the ends of the bent piece moved rather too fast for comfort and it was therefore necessary to cut down the speed of the flywheel by inserting resistance in the armature circuit of the motor which drove the line shaft to which three of these presses were belted.

Finally, there is one thing more which has just struck me and to which I would like to refer. I had almost forgotten to put in a good word for the clutch lock used on the press which enables the diemaker to set the dies without throwing the belt—a convenience which must be used to be appreciated to its full extent.

* * *

Inasmuch as every structure built of inflammable materials has within itself the potential elements for its own destruction it should also have the elements for subduing fire, which means an independent water supply and means for automatically distributing same to drown out incipient blazes. In other words, every structure of importance which is not fireproof in every particular should be an independent unit so far as fire fighting is concerned, having within itself complete fire fighting apparatus. This lesson was forcibly impressed by the great fire following the earthquake shock in San Francisco in April. That fires should follow such a crash was but a logical consequence but it is doubtful if the fact that such a shock would paralyze the water system by breaking the mains had ever been seriously considered by the city engineers. In all probability the prevention of such disruption of the water system by severe earthquake could not be prevented, but if the principal large buildings in the commercial districts had been provided with generous sized water tanks and sprinkler systems throughout, the fire loss in this part of the city could have been greatly reduced no doubt. The principle of making every large building independent in fire fighting facilities is one that has been adopted by factories generally, but its extension to commercial buildings in large cities has been comparatively slow. When we consider that any city water supply may be temporarily put out of business by a variety of causes any of which may operate at a critical period it seems that the rule, as laid down in the foregoing, should be very strictly enforced.

DESIGNING AND BUILDING A MACHINE PART.

H. P. FAIRFIELD.

The machinist is apt to concern himself but little with the steps taken by others to produce the castings which he is given to finish into machine parts. He seldom gives the designer or draftsman a thought, and the patternmaker or molder gets less. It may be of general interest to follow along the path a piece has taken from its first inception in the designer's brain, to the point where it becomes a finished part of a useful machine, and to count the footsteps. Take, for example, a worm gear such as that shown in Fig. 1, which is part of a friction feed mechanism. Topsy "just growed," but this is not true of a machine part, either in design or workmanship, and even so simple a piece as the one shown represents thought by the designer, patternmaker and foundryman. The designing draftsman should be something of a pattern-

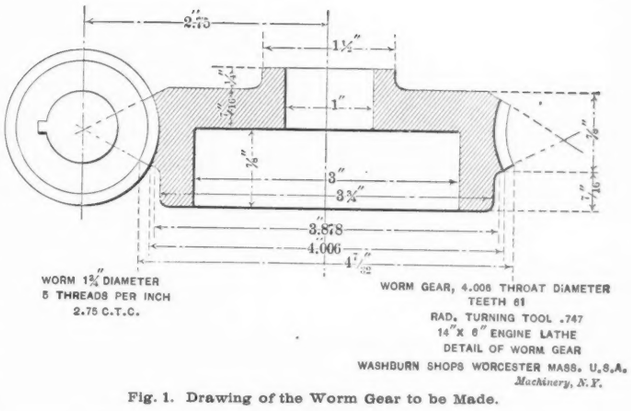


Fig. 1. Drawing of the Worm Gear to be Made.

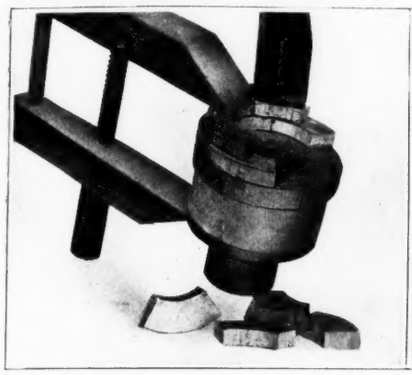


Fig. 2. Gluing Up the Pattern.

Fig. 3. The Hub and Finished Face of the Pattern.

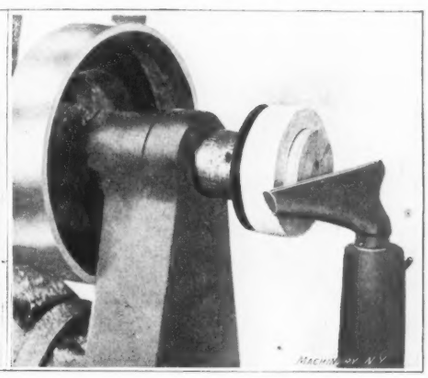


Fig. 4. Turning the Wood Chuck to Fit the Pattern.

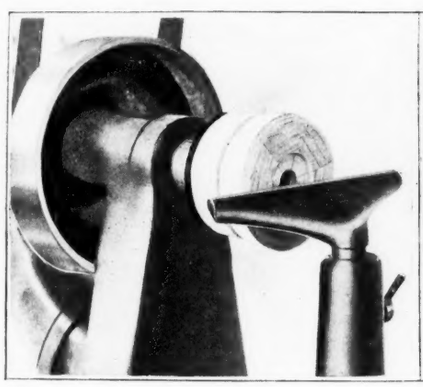


Fig. 5. Turning the Seat for the Hub.

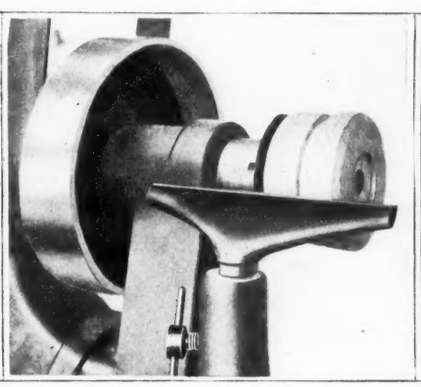


Fig. 6. The Seat Completed.

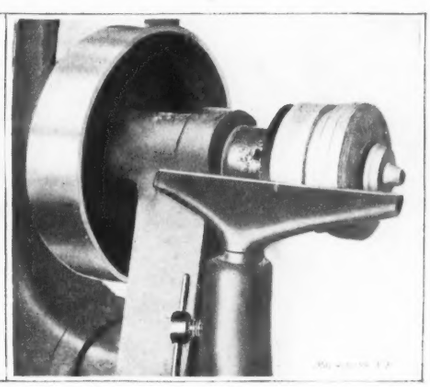


Fig 7. Trying in the Hub.

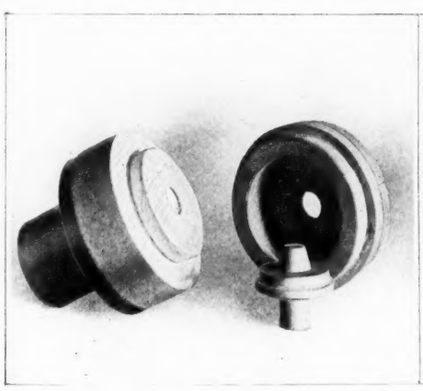


Fig. 8. The Completed Body and Hub.

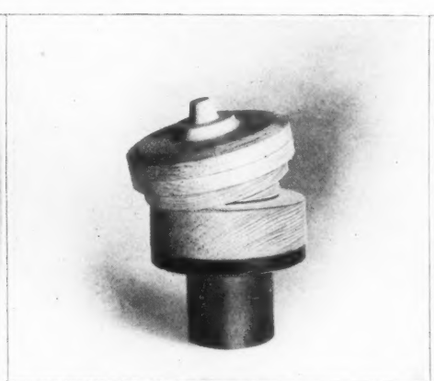


Fig. 9. The Assembled Pattern.

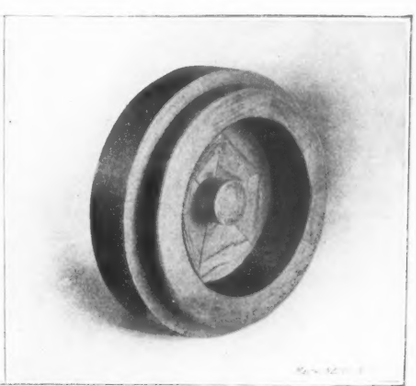


Fig. 10. Pattern Finished and Shellacked.

maker, foundryman, and machinist, in addition to his ability to assign proper values to form, strength, velocity ratios, position, etc.

The patternmaker is concerned with questions of shrinkage and warping of the materials used in making the pattern. He is also concerned with the foundry and machine shop problems of shrinkage, draft, finish, ease of molding and machining. Fig. 2 shows the best method of gluing up a pattern to provide for uniform shrinkage, prevent serious change of form by warping, and give strength. Such a pattern finishes nicely under the cutting tool, as shown in Fig. 3. The core print and hub are, however, turned from the solid and after-

ward glued into place. Strips of paper glued between the first layer and the face-plate board allow the pattern to be removed at this stage and the board is shouldered to fit snugly the recess in the pattern, as shown in Fig. 4. Wood mounted on a face plate and afterward used to hold work by gluing, shouldering, recessing or any similar manner is termed a wood chuck, and Fig. 5 shows how the work is held true and firm in this manner. In this position it is trued off and the hub recess turned

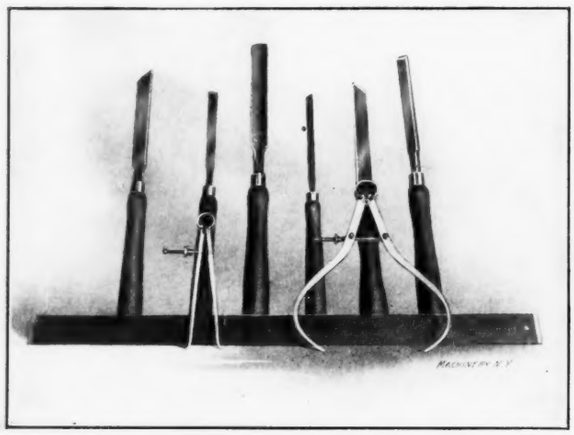


Fig. 11 Tools used by Patternmaker.

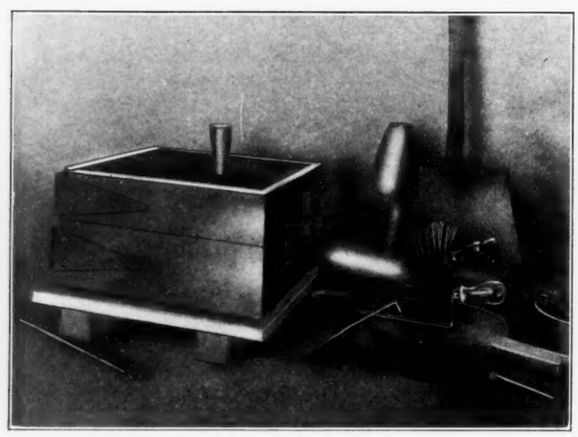


Fig. 12. The Mold and the Molder's Tools.

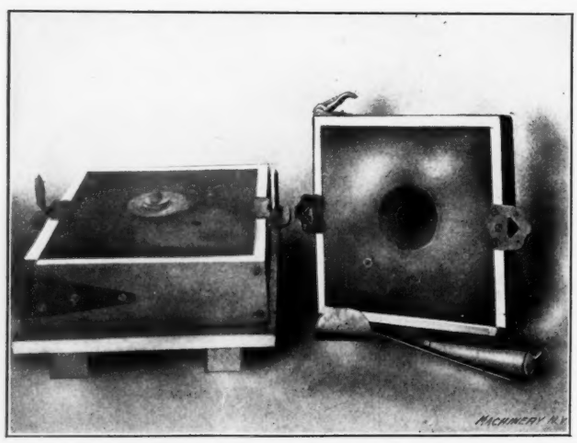


Fig. 13. Ready to Draw the Pattern.

to a fit. Fig. 6 shows the tool rest swung to a position that allows the hub to be tried into the recess, as in Fig. 7. Fig. 8 is the pattern removed from the chuck with the hub and core prints ready for gluing into place. This shows in Fig. 9, and in Fig. 10 the pattern is shellacked ready for molding. The tools used by the patternmaker appear in Fig. 11.

Considered from the viewpoint of the foundryman, a pattern is a useful but not an indispensable tool, and with it he can more easily produce the required castings. Such a pattern as the one shown makes a simple molding job, if a molding job of any sort can be termed "simple." In Fig. 16 are the two parts of a flask made hinged so as to be snapped open by the molder to remove it from the sand mold, and in Fig. 12 is the sand mold complete with the taper plug that forms the gate in place. Some of the tools used by the molder are shown in this view. For convenience in handling the upper and lower

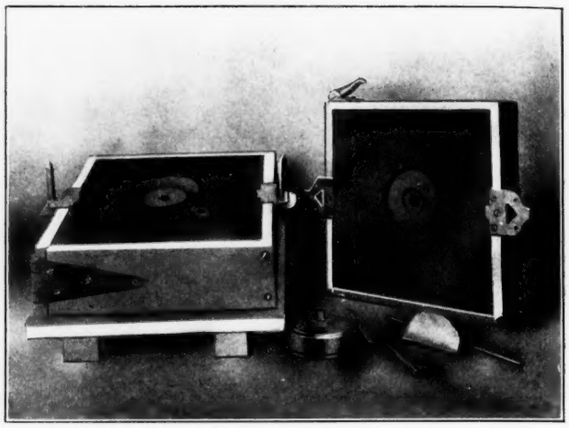


Fig. 14. The Pattern Drawn.

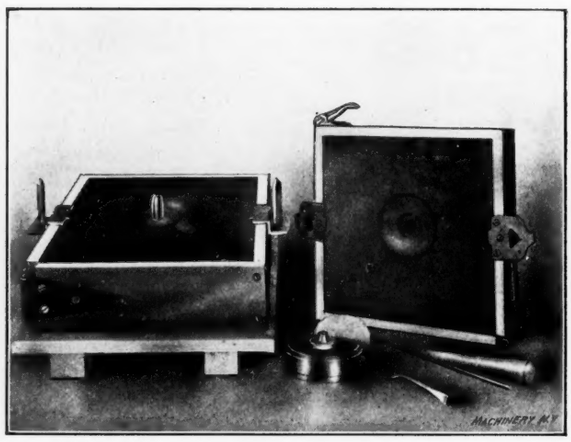


Fig. 15. The Core in Place, ready for Cope.

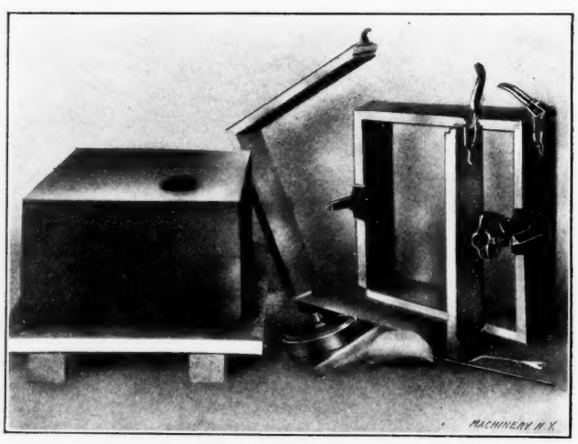


Fig. 16. The Completed Mold.

parts of the flask—termed the *Cope* and *Nowel*—as much of the pattern as its shape will allow is bedded into the nowel, as in Fig. 13. With the pattern withdrawn as in Fig. 14, a cavity is left for filling with the melted metal. As a portion of the cavity is in the cope, the flask needs to be closed when poured. To lead the metal into the cavity made by the pattern, a gate is cut beside it out to that left by the tapered plug. This is shown in Fig. 15. To form a hole in the center

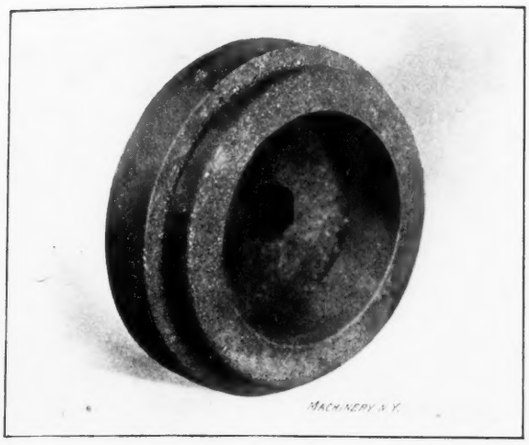


Fig. 17. The Rough Casting.

of the casting a sand core is placed in that part of the cavity left by the core prints, and the mold is closed and the flask removed. The mold now presents the appearance of Fig. 16, and is ready for pouring. It will be seen from this figure that the outer part of the gate has been enlarged to form a basin

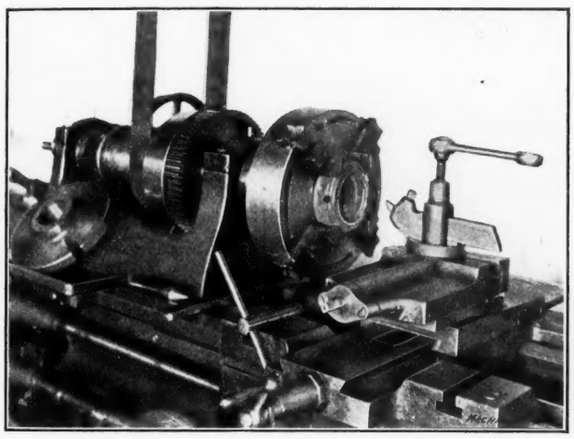


Fig. 18. Truing up the Casting in the Chuck.

into which the molten metal can be conveniently poured. After the mold is poured the sand is broken apart and the casting is allowed to cool until it is ready to be placed upon the pickling bed and prepared for the machine shop processes and appears as in Fig. 17.

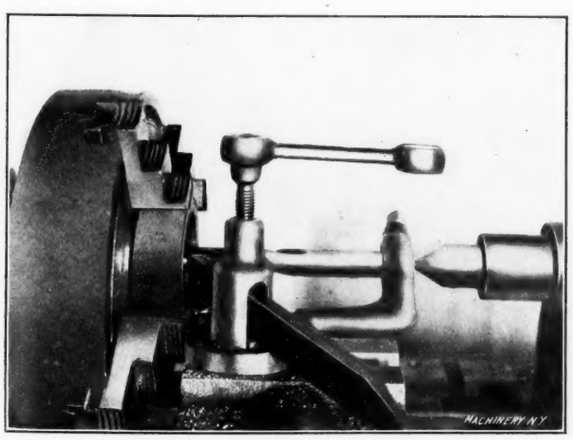


Fig. 19. Drilling Out the Hole.

The first operation on the casting in the machine shop is to true it up in a lathe chuck and finish out the hole. To insure a satisfactory hole three tools are used: a drill, lathe reamer and hand reamer, in the order named, each tool leaving the correct amount of stock for the succeeding one. To indicate the position of eccentricity when truing up the piece in a chuck, either chalk or a lathe tool may be used. Fig. 18 shows the piece ready to be drilled and lathe reamed, Fig. 19 and Fig. 20 completing the operation. If the drill tends to wabble when it is being started, the butt end of a lathe tool held as in Fig. 19 steadies it. The back surface of the recess can be more easily finished when held in the chuck than after-

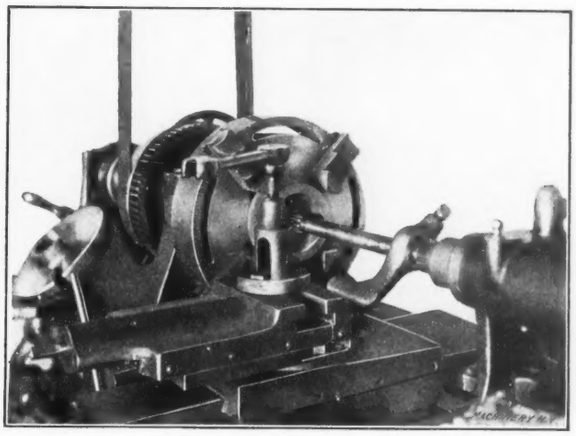


Fig. 20. Reaming the Bore.

ward. Figs. 21 and 22 show this being done. The outer edge is squared first for convenience in scaling the depth of the recess.

Fig. 23 illustrates the finishing of an internal circumference true with the hole. While it was good enough practice to

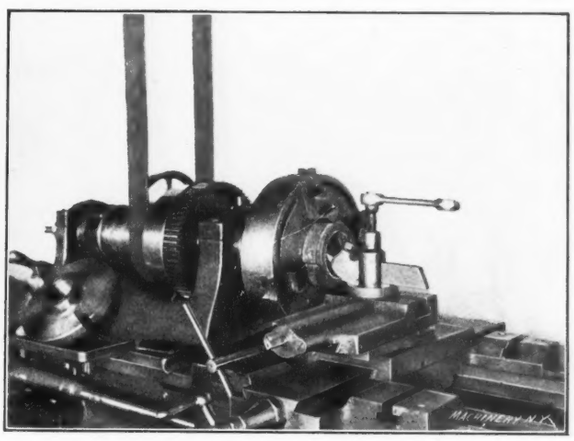


Fig. 21. Roughing the Back of the Recess.

rough out and finish the inner radial surface while the piece was held in the chuck, it is necessary that the split ring bearing and gripping surface be practically true running, and this involves finishing this surface on a true running mandrel.

In roughing out and finishing the outer circumference, as in

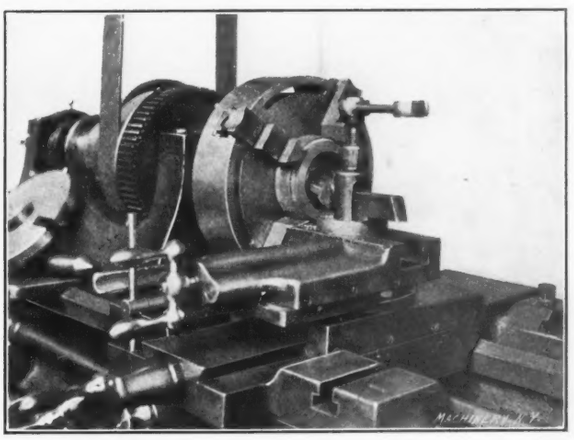


Fig. 22. Finishing the Recess.

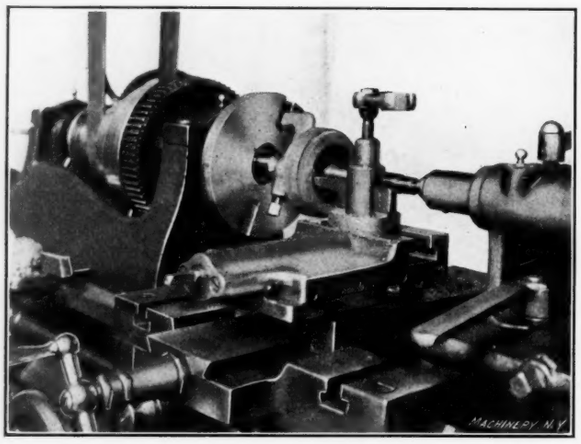


Fig. 23. Finishing the Inner Circumference.

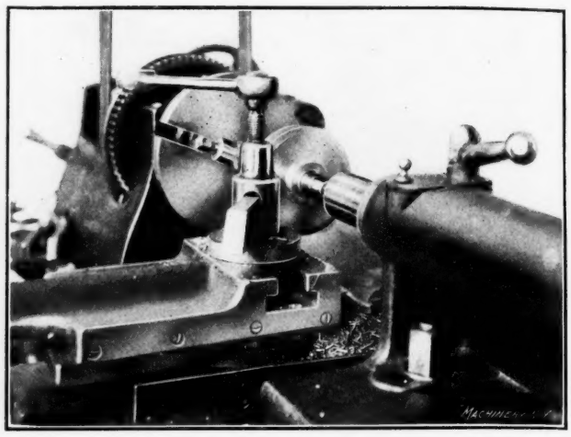


Fig. 27 The Finished Surface.

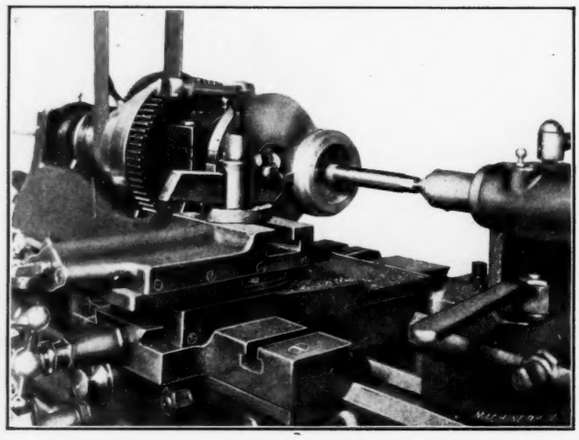


Fig. 24. Rough Turning the Outside Diameter.

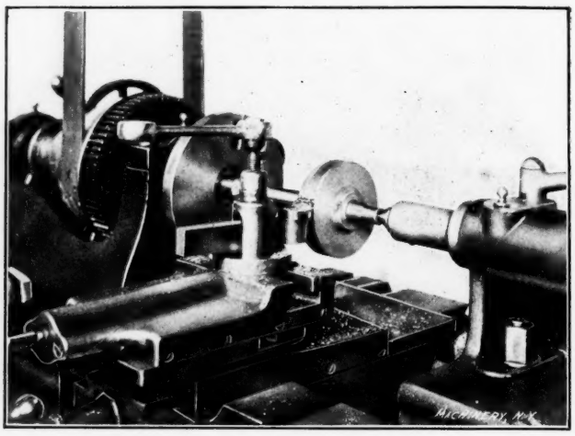


Fig. 28. Radius Tool for Tooth Surface.

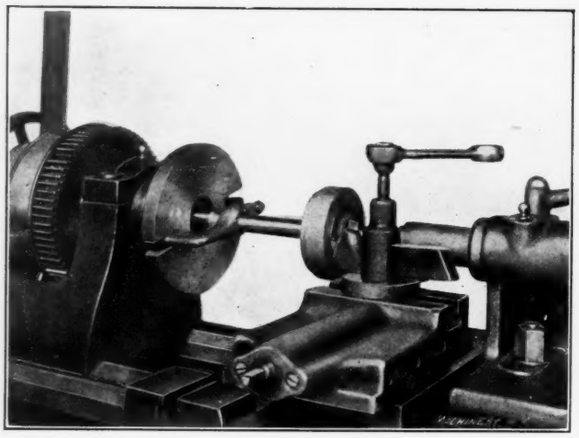


Fig. 25. Roughing the Outer Face.

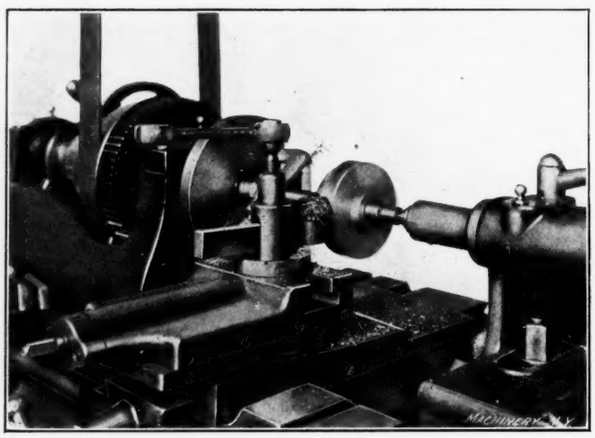


Fig. 29. Chips made by Radius Tool.

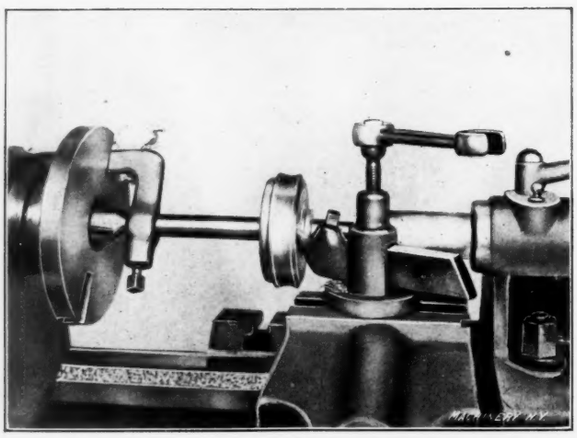


Fig. 26. Finishing the Face with a Scraping Cut.

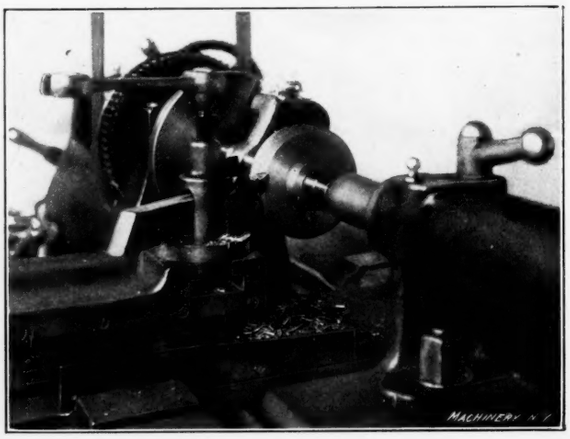


Fig. 30. Chamfering the Corner.

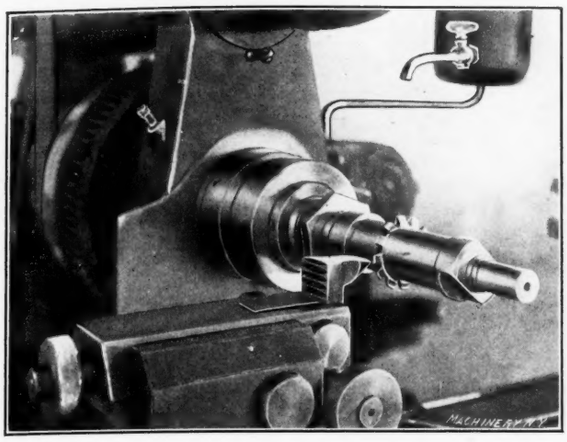


Fig. 31. Centering the Gashing Cutter.

Fig. 24, the concaved surface for the teeth is left as the lathe tool leaves it.

Roughing the outer radial surface, as shown in Fig. 25, is best done by feeding from the outside towards the center, as

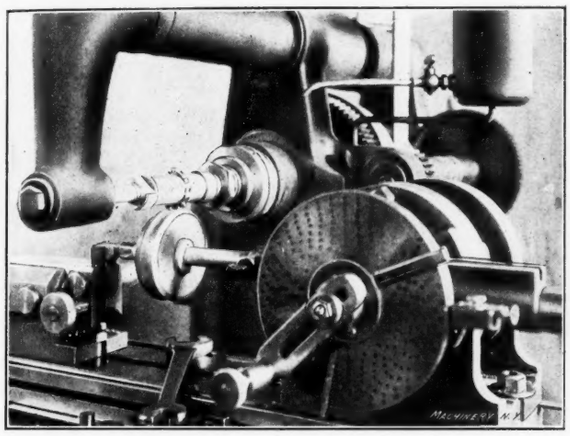


Fig. 32. The Cutter Located with Reference to the Blank.

the hard skin or scale of the casting is pried off or crumbles ahead of the cutting edge.

Finishing this surface is done by lathe scraping, which leaves a smooth, polished surface. For this purpose the tool

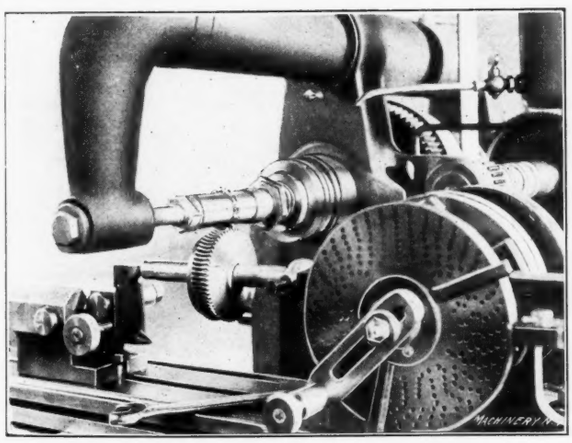


Fig. 33. Gashing the Worm Wheel.

is fed in the reverse direction from that of roughing, or from the center outward. Fig. 26 shows the method and Fig. 27 the results.

The concave surface upon which the teeth are cut is easily made, as in the illustration, Fig. 28, by means of a radius tool. If a comparatively slow speed is used and a firm, steady feed, the tool will not give trouble by chattering. The fact that such a tool removes actual shavings when properly used is clearly shown in Fig. 29. When the corner has been beveled or chamfered, as in Fig. 30, the piece is ready to have the teeth cut on its circumference. Before doing this it may be well to consider briefly the way in which the teeth *may* be cut. Worm gears used as adjustments do not need to have other than line contact between the teeth of the worm and gear, and suitable teeth may be formed by using a single cutter of the proper curvature. This is very clearly shown by the

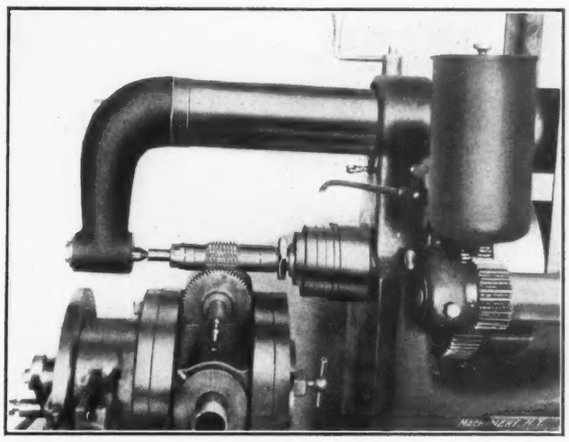


Fig. 34. The Hob in Place.

Brown & Sharpe Mfg. Co., in their treatises on gears and the milling machine. Where, however, the worm and gear are used to move a load, as in the case of a feed works drive, surface contact between the teeth is made necessary. To

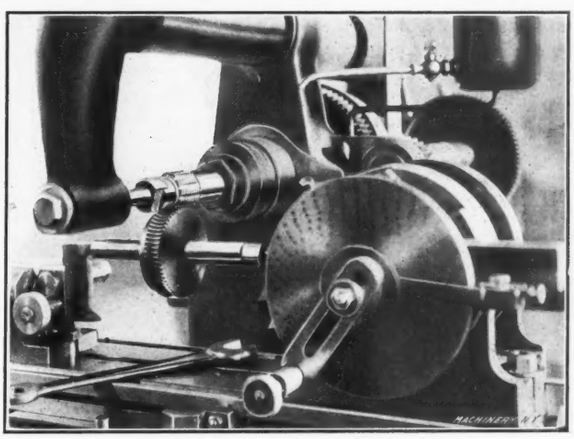


Fig. 35. The Finished Worm Gear.

obtain this they are formed by a cutting tool termed a "hob," and the operation is called "hobbing." If the hob is allowed to space the teeth without previous "gashing" it will cut a larger number of teeth than is desired upon the given cir-

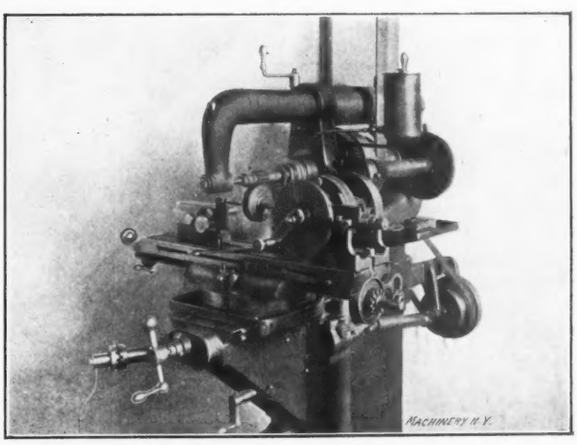


Fig. 36. Milling Machine Set Up for Hobbing.

cumference. Gashing corrects this and can be done by using any cutter that will leave enough stock upon the sides of the teeth to permit finishing by the hob. The gashing cutter may be set central, as illustrated in Figs. 31 and 32. Gashing after the cutter is properly set is a question of indexing the required number of spaces and of feeding the work vertically against the cutter to give the allowed depth. The worm gear being a portion of the back section of a nut, its teeth will have a *left-handed* angularity if the worm is *right-handed*. The work table should be swiveled to give this when the blank is gashed and afterward set to zero when hobbing the teeth. After the spaces have all been indexed as in Fig. 33, the dog is removed from the mandrel and the hob placed in position, as shown in Fig. 34. In this position, and mounted as shown, the hob forms up the teeth and rotates the blank. The feed is vertical as for gashing, and to such a depth as necessary to give the required distance "center to center" of worm and gear. The finished job is shown in Fig. 35, and a general view of the machine in Fig. 36.

* * *

CHOOSING AN EMPLOYER

CON WISE.

When we used to go to Sunday school we all made resolutions prompted by what we heard there, that when we went to work for a living we would be the first ones down in the morning and the last ones home at night and that our diligence would be so noticeable that our employer would shortly call us into the office and pat us on the head and say, "Johnny, my boy, you are too valuable a man to be taking down shutters, come in and run my business and marry my daughter." And yet most of us are still working for so much every Saturday night. Now since we are all diligent in business and all know at least as much about it as the boss and none of us have any objections to the daughter, there must be something at fault besides ourselves. The least particle of logic shows that this is the employer himself. The trouble is that we are too hasty in selecting our employers. And a moment's reflection will show how important it is that we should be careful. On the average each employer hires say 50 hands. If one fails to follow his Sunday school teaching it is only a percentage of loss on 2 per cent of his force. If one of his hands finds that the head of the firm is of an uncongenial nature and quits he loses 100 per cent of his job.

Ten or fifteen years ago I heard a well-known engineer in the course of an address to a graduating class of a technical school advise them to take the first job that came along. Two or three years later I called at his shop to see his superintendent. I was referred to his home where I spent a most enjoyable half hour sitting on packing boxes with the ex-superintendent and got a side light on his former employer which seemed to explain the latter's remarks to the graduating class. It seems that he never kept a superintendent over two years and a good many less than one even though he was willing to pay good money. He evidently thought that all men traveled from one job to another so fast that a few false steps would do no harm. This man was like a lot of others, so good an engineer of materials that he had no time to consider his men in any other light than as so much additional material to be hewed or bent this way or that as his whims changed. Almost all the great successes in manufacture have had somewhere near the top some man whose knowledge of engineering may have been limited but whose ability to get the best out of subordinates was marked.

If a man wants his life to be worth living he must labor at such work and under such conditions that he can enjoy it. If he has to get all his pleasure outside of working hours it costs too much and keeps him up too late. If the work itself is congenial it is not enough. The atmosphere must be congenial too. If you can work with your employer rather than for him it is a great thing. With some employers this is impossible. They cannot conceive of a man to whom they pay wages standing on any plane of equality with them. If an employer is a large enough man so that he is likely to succeed he can afford to let his employees have all the glory that they can get. And if he is a student of human nature he knows that a share in the glory, or even a reflection of glory goes a long ways toward staving off a demand for more salary.

One way in which you can find out how good a man is to work for is to see how long his best men stay. You don't care anything about what the "floaters" say. The first man I ever worked for had an almost world-wide reputation for crankiness toward his help. But out of a crew that ranged from 30 to 50 men he had about 20 men that stayed right along anywhere from 5 to 25 years at a time. The rest were a floating population that came and went as business rose or fell. He didn't like to discharge help so about the time business dropped off he earned his reputation so fully that men were glad to leave. If a man could stand him for a year he could have a life job and do about as he pleased. Then there is the man who invariably opposes every suggestion that is made, then takes it home, dresses it up in a new form, brings it back and adopts it as his own. That kind is too narrow minded to live with. You must look out too that you don't stay too long with an employer who has disagreeable ways. There is danger of contamination. This reminds me of a family of Quakers who used to and probably still keep a large store in my native town. They were the squarest people I ever met and the softest spoken. I was acquainted with them over quite a number of years during which time they had several different men in the office. These men were of all kinds when they went there but after working a year they became as like their employer as men could become in manners and speech. It got so that it was almost impossible to tell who was answering the telephone. This is only a single instance of the influence of one man's character on another and I presume your readers will recall many more. The only trouble is that it seems as if character is more easily influenced for ill by association than for good. In one shop that I know of the proprietor addresses his foremen as Mr. So-and-So, and they in turn use the Mr. in speaking to the men. And the men in that shop will help each other if they need a hand's lift for a moment. No traveling over to the scratcher's bench to get a helper to put on a center nut. They all know that the proprietor could afford a silk hat if he wanted it and that he will, and wants to, help a man if he sees the need. These men don't snatch their pay envelopes like wild beasts after they have been there a month, and they don't swear, that is, not long abusive swears, and more than that, they are loyal to their shop and work for the shop, and not alone for themselves

Whether it is necessary to always work for successful concerns is a question. Of course no one deliberately takes a position with a concern which is known to be failing but on the other hand I don't believe that it is always wise to desert a sinking ship even if the rats do. There have been lots of rescues just at the last moment that have carried faithful employees up high on a tide of prosperity, and I never knew of a man being turned down for a good job because he worked for a concern that failed, unless he was suspected of being responsible for the failure and even then such an experience is generally understood to have an educational value. A distinctly successful concern can usually hire men for less money than one which is in the formative stage but then there is less chance for advancement in the former so it is worth less. As for a choice between working for a tactful man and a blunt one, it is largely a question of pocketbook *versus* feelings. A tactful man will pay his help quite liberally in diplomacy and hopes while the other man pays all cash, against which you can be almost sure to have to set off some loss of self esteem if not of self respect.

There is hardly a man but that can find somewhere an employer under whom he can work with comfort and pleasure, and under no other ought he to work longer than to try him out, for there are plenty of jobs for conscientious men, and this is written for no others. But even after you have secured a good employer you must keep close watch of him for he may change. His personal life is none of your affair up to a certain point but you may be sure that if you find him drinking or gambling you had best make it your personal affair to get another job. Then too an influx of relatives in his shop is a poor sign, for no matter how good an employer he may be, they will act like a bit of smoked glass held up between you and him and you might as well surrender.

DWIGHT SLATE.

REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS.

Dwight Slate was born in Gill, Franklin County, Mass., May 29, 1816. At the age of 17 he entered the machine shop of Eli Horton, Stamford, Conn., as an apprentice, but so apt was he in mechanical and business sense that before the term of his apprenticeship had expired he was made a partner. Horton manufactured textile machinery and also built various machines to order, which work gave Mr. Slate very valuable experience. During the twelve years of service with the Horton shop he designed a number of new machines, among which was one for rifling gun barrels with what is known as the "gain twist."

Leaving the Horton shop in 1845 he formed a partnership with F. M. Brown, the concern being known as Slate & Brown, which located in Windsor Locks, Conn. Here a shop three stories and basement, 40 x 80 feet, was built, where they made textile machinery and fitted up many textile mills in Massachusetts and Connecticut. They also built special machines to order, and when Col. Colt received his first order from the United States government for revolvers, Slate & Brown made, on contract, barrels and cylinders for Colt's revolvers, which were used to a limited extent during the Mexican War. Mr. Slate designed a number of special machines and tools for revolver manufacture, and many of the machines of his design were afterward used in Colt's Armory, where they proved to be very valuable.

At this period the planer was a machine tool found in very few American shops and Slate & Brown installed one of the first iron planers to be used in the Connecticut Valley. With it they did much planer work for other machine manufacturers, work being sent to them from towns as far distant as New Haven. Finding their venture so successful they shortly after got out patterns and started to build planers, which were among the first of the rack and gear type in this country. One of the first of these was sold to Geo. S. Lincoln & Co., of Hartford, afterward known as the Phœnix Iron Works. Planed surfaces were then produced in most shops by chipping and filing, and when Slate & Brown announced to their workmen that they had ordered a planer for their shop, some of the men wanted to strike, as they thought it would deprive the chippers and filers of their means of livelihood.

Early in the year 1850 Mr. Slate ventured into the Southern field, going to Augusta, Ga., to install textile machinery in some of the cotton mills then being located in that vicinity. He remained in the South about five years, during part of which time he was connected with the Augusta Machine Works, which afterward built railroad cars. Shortly before the outbreak of the Civil War, he returner north and became a general contractor in Colt's Armory at Hartford, where he made important improvements in the methods of manufacture of firearms, bringing out among other inventions an improved rifling machine which is practically the same as that used in nearly all of the government armories at the present time. With the close of the war the demand for firearms of all kinds practically ceased, and leaving Colt's he became connected with the comparatively young firm of Pratt & Whitney as a designer of tools and machines. It was with the Pratt & Whitney Co. that he invented and patented the lathe taper attachment for turning tapers on the engine lathe without setting over the tailstock, which is now in general use. This patent he sold to the Pratt & Whitney Co. for $10,000, and it is conservative to state that it was one of the best investments that Pratt & Whitney Co. ever made. It was a basic patent and was never contested during its life. It gave the Pratt & Whitney lathe great advantage for toolroom work, and in many cases formed the thin edge of the wedge by which a great volume of business was afterward secured.

Early in the seventies Mr. Slate started a shop of his own in Hartford to build special machines for various purposes. About this time he got up and patented the Slate cut-off tool and a center grinder for grinding lathe centers; he also originated the type of small drilling machine known as the "sensitive drill," that is, the machine which in its original conception was so constructed that the driving belt would slip before the drill would break. The so-called sensitive drill of the present day of course is wide of the mark in this respect, but the direct application of the driving belt to a pulley on the drilling spindle, together with other features, which mark this design, have made this machine one of the most valuable of small machine tools.

In 1885 Mr. Slate incorporated his business under the present name of the Dwight Slate Machine Tool Co. to manufacture a line of light machine tools, most of which were of his own design. He is now nearly 90 years old, but is still in good health and takes great interest in current events of the day, although not engaged in active business.

* * *

In a country blacksmith shop in Altay, N. Y., there is an old foot-power metal turning lathe that was built by Amos Kendall more than half a century ago. It is very crude in construction, having wooden shears, but containing a number of features of interest, among which is the arrangement for cutting screws. The lead screw was made very short, presumably because of the difficulty and cost of cutting a long screw at that time. A split nut is provided which is connected to the carriage by a reach-rod of adjustable length so that no matter on what part of the work between the centers the thread has to be cut the reach-rod may be adjusted so as to cut the thread. Unconsciously this early mechanic used a scheme an element of which has been demonstrated to be well adapted for precision work, or, to be more exact, it has been shown to be practically impossible to make a long lead screw precise in all its parts. Even granting it could be made, it would be impossible to maintain its accuracy. A short screw, thick in proportion to its length, can be made of almost any reasonable accuracy and if a nut of equal length is used the wear will be uniform in all parts. A lathe is in use in the Straight Line Engine Works at Syracuse which has an 8-inch solid nut and an 8-inch precision screw designed by Prof. John E. Sweet. The screw is hollow and is larger than the regular lead screw, being mounted as a sleeve upon it. Provision is made for holding it fast to the lead screw and for fastening the nut to the apron. When threading piston rods (for which work it is used) the nut is so adjusted that it travels equally each side of the center of the screw, thus making the wear uniform on both sides.

* * *

It is claimed that the particles of India ink when examined under a powerful microscope are found to be moving about with immense activity, and this movement, which is characteristic of inks in general, is said to be the reason why true inks do not settle. The addition of certain salts, however, stops the rapid motion, whereupon the particles group themselves together and descend to the bottom in precipitate form.

A NAVAL GAS ENGINE.

M. JOACHIMSON.

The idea of the gas engine for marine propulsion, in connection with a gas producer, is not a new one, since its advantages for this purpose were discussed soon after the appearance of the Otto 4-cycle engine. The marine service, however, requires so many special conditions of the gas motor that it is not surprising many years elapsed before the marine gas engine became a practical machine. The disadvantage of the stationary gas engine, compared with the steam engine, is that the former is not as economical under variable load, although of superior economy at normal load. In marine work the engine generally runs under full load and in this case the gas engine operates with a heat efficiency of 26 per cent as against 15 per cent for the best steam engine—an efficiency which can only be attained in the largest sized units. A high efficiency for the gas engine, however, may be maintained, even in the smaller sizes.

In what follows is a description of a marine engine and producer developed by M. Emil Capitaine of Frankfort-on-the-Main, and an account of the methods used in overcoming some of the difficulties encountered in perfecting the apparatus. M. Capitaine employs a suction producer.

In a suction gas plant the producer takes the part corresponding to the boiler of a steam plant. The simplest producer consists of a cylindrical vessel in vertical position made of boiler plate and lined with fire brick. A mixture of air and steam is sent through a mass of red hot coal contained in this producer. The carbonic acid developed by the combustion is decomposed into carbonic oxide by passing through the upper layers of fuel. The gas so produced contains about 120 B. T. U. per cubic foot. If steam passes with the air the gas is of the following composition:

Carbonic Acid (CO_2)	6 per cent.
Carbonic Oxide (CO)	26 per cent.
Marsh Gas (CH_4)	5 per cent.
Hydrogen (H)	14 per cent.
Nitrogen (N)	53 per cent.

Fig. 1 shows the elements of a producer plant. The gases leave the producer *A* with a temperature of about 930 degrees F. and go through the evaporator *B*, where their heat is utilized to raise steam. The latter is led by a pipe under the grate of the producer through which it flows into the mass of coal and is there decomposed. After passing the evaporator the gas reaches the scrubber *C*, which vessel is filled with coke, constantly sprinkled by cold water, the non-combustible

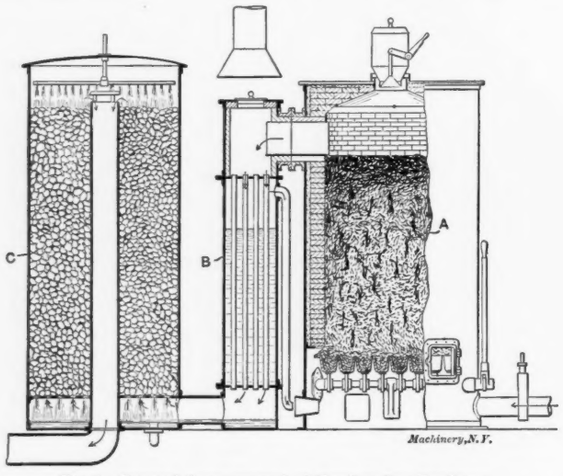


Fig. 1. General Arrangement of Suction Gas Producer.

ingredients of the gas become separated by touching the damp surface of the coke. The suction end of the gas engine is directly connected with the outlet of this scrubber, and at every stroke the engine draws a mixture of steam and air through the hot fuel bed *A*, and the hot gas developed passes the evaporator *B* and scrubber *C* to reach the suction valve of the engine. To assure a proper working of the engine a steady gas supply of uniform quality is needed. This can only be attained if the surface of the coal presented to the passing steam, air or gas remains constantly of equal size. If anthracite or coke is used this condition is easily met, but with soft coal it is a problem hard to solve; as the contents of the producer clinker to a solid mass and either inhibit the flow of gas or else fissures appear and the air passes through them without decomposition. In both cases the result is a very poor gas. Anthracite requires per horsepower about 400 square inches of surface, which is represented in 160 cubic inches weighing 5.5 pounds. Coke requires a little more, but if soft coal is used the surface varies, growing smaller as the fuel gets hotter.

A producer designed for 1,000 horsepower will, if used with soft coal, supply gas for only 200 to 300 horsepower when

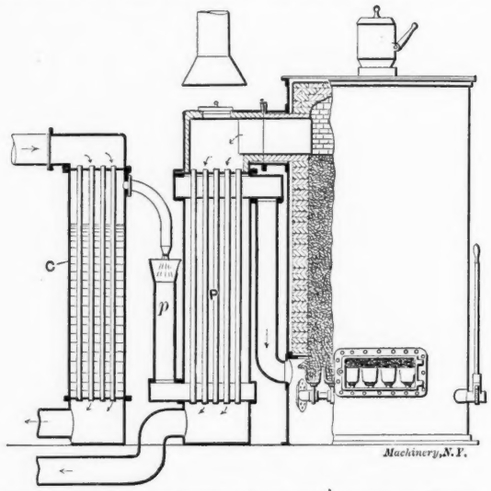


Fig. 2. Producer for Utilizing Heat of Exhaust from Engine.

the coal becomes incandescent. For this reason producers using ordinary coal must be built very high to prevent the air passing through the open fissures without coming in intimate contact with the hot fuel. A producer of 2,500 horsepower using soft coal would be 10 feet inside diameter with a depth of coal of 10 feet; and with outside dimensions of 14 feet high and 12 feet diameter. The weight (as this must be considered like the water in a boiler) is 40 tons, against 200 to 250 tons for the boiler of a tug or a yacht or 35 to 40 tons for a water tube boiler of a cruiser. If harder coal is used, which is less liable to clinker, the dimensions may be considerably reduced, the generator in this case being only 10 feet high instead of 14 feet.

The following comparative figures are of interest:

The space for Scotch marine boilers is about 14 cubic feet per horsepower and the weight about 200 pounds per horsepower.

The space required for water tube boilers is about 5.3 cubic feet and the weight about 51 pounds per horsepower.

The space required for a gas producer is 1.75 cubic feet and the weight 51 pounds per horsepower.

These figures do not include the water purifying apparatus and the steam generator for gas. The weight and space for the water, however, may be compared with the weight and space for the condenser plant of the steam engine, which is also not included in the above figures.

The purity of the gas is of the highest importance for the proper working of the engine. Gas which contains tar is injurious for the engine, as coal tar collects in the cylinder, covers the piston and clogs up the valves, and finally, heated by the explosion, it causes pre-ignition. For this reason it is desirable to design these motors in such a way that they may easily be cleaned. To avoid the tar in the gas as much as possible producers were designed with two layers of combustible, one above the other. The air enters from above, with steam from below, and the gas is taken off at the center, the hottest part of the producer, without passing any new and tar supplying coal. For marine service this style generator would be too high and a modified form was designed with double furnaces, side by side, and with the coal fed in between them automatically by a screw conveyor or stoker.

To increase the efficiency of the producer the gas engine exhaust was made to pass through the evaporator *C*, Fig. 2, and the steam so generated was mixed with air at *p* and

passed through a superheater *P*, the pipes of which were heated by the gases coming from the generator. The air and steam mixture enters the fuel bed highly superheated and by this system 90-95 per cent of the heat contained in the fuel may be realized in the gas. The amount of water needed for evaporation is about ½ pound per horsepower for a coal consumption of ¾ pound, but it is more favorable to have a slight excess of water. For salt water the evaporator mentioned before would be impractical on account of incrustation,

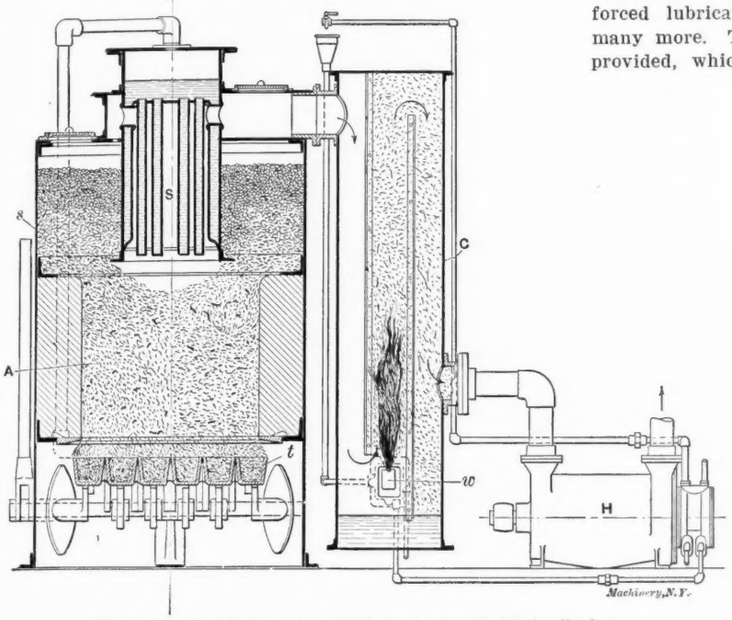


Fig. 3. The Producer used by M. Capitaine for his Marine Engine.

and a special purifier has to be provided. The one shown in Fig. 4 is designed in such a way that the concentration of sea water cannot exceed a certain limit, since the water flows continuously through the purifier. The fresh water enters at *a*, passes upwards through the coil *t*, whereupon it enters the condenser and is evaporated to contain 3 to 4 per cent of salt. This saturated hot water flows into the space *s*, heating the coil and the fresh water in the same, and escapes through the discharge *z*. With a sufficient heating surface the heat losses in this purifier are inconsiderable and it needs cleaning in long intervals only.

One of the greatest difficulties of a producer for marine purposes for tugs, yachts, etc., consists in the falling off of temperature in the generator, when the engine either stops or works at half power. At such times the temperature in the producer drops more or less, which in turn reduces the heating value of the gas so much that the engine will not start up immediately at full power. The larger the dimensions of the producer the longer can a constant temperature be maintained; but in generators up to 150 horsepower the temperature drops quite rapidly. For marine propulsion the gas engine would be absolutely of no use if this problem were not solved, and it has been accomplished in different ways.

The design of the new Capitaine producer and gas engine is illustrated in Figs. 3 and 5. The gases produced in the generator escape from its hottest part and heat the pipes of the evaporator *S*; and as they cannot come in contact with fresh coal, they carry but little tar. They now pass to the cleaner and cooler *C*, into which water is sprayed at *w*. The close contact with the large surface of water washes them thoroughly. The centrifugal dryer *H*, which has a circumferential speed of 300 feet per second, serves the double purpose of drying the gas-water mixture and of removing all solid particles from it. It delivers a very pure gas to the engine, which is directly connected to the dryer. This system of cleaning the gas requires an exceedingly small space and is therefore specially suited for marine purposes.

The fuel used is anthracite or coke and in its fresh state surrounds the evaporator *S* wherefrom it falls into the furnace *A* through an annular opening. The grate also is of special design, the bars being of channel section containing ashes inside and cooled on the outside by the air led into the generator.

The Capitaine gas engine used with this producer is a 4-cycle, multi-cylinder engine with frame of structural shapes to reduce the weight. The different parts of each valve system can be cleaned entirely independently of the others.

Many other details are specially designed for marine service as the automatic timing of ignition with varying speed, forced lubrication, automatic starting of compression and many more. To start the engine a small gasoline motor is provided, which however works a few minutes only every

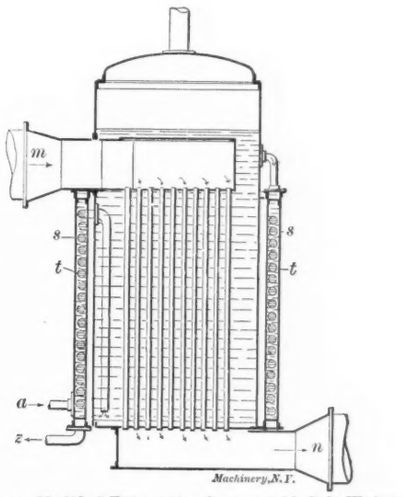


Fig. 4. Modified Evaporator for use with Salt Water.

day. The boats are reversed by adjustable propeller blades, up to 100 horsepower. For larger boats this is done by a reversing gear arrangement.

The consumption of coal per horsepower hour is stated to be one pound for engines up to 30 horsepower, 0.88 pound for an engine of 50 horsepower, and 0.82 pound for an engine of 100 horsepower.

For purposes of comparison tests were made on November 8th, 1904, upon *Gastug* and the steamer *Elfriede* before the Dock Department at Hamburg.

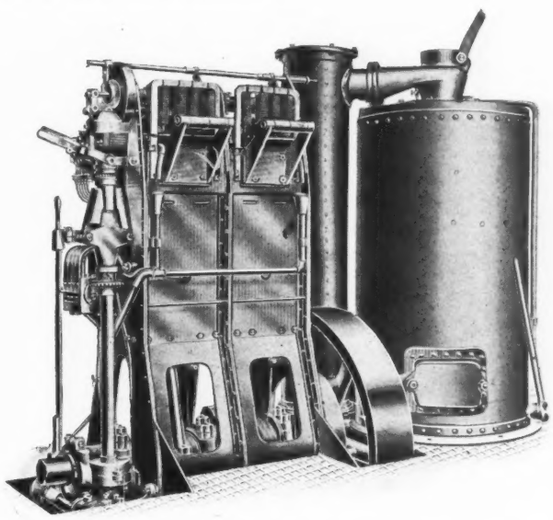


Fig. 5. Complete Producer and Engine Plant for Marine Service.

Gastug is 44 feet 3 inches long, 10 feet 6 inches beam, and is fitted with a 70 horsepower Capitaine producer gas plant.

The *Elfriede* is 47 feet long by 12 feet beam and fitted with a triple expansion steam engine developing 75 horsepower.

At the towing meter *Gastug* attained a maximum pull of 2,140 pounds and the *Elfriede* of 2,020 pounds.

A run was made by these two boats during very stormy weather at a maintained speed of 8.5 knots. The consumption of fuel was as follows:

For 10 hours *Gastug* 530 pounds German anthracite; and *Elfriede* 1820 pounds steam coal. While these results are exceptionally satisfactory for boats of small size, the inventor who tries to conquer the field of marine propulsion for gas engines as applied to the largest ships has much greater problems to contend with. In the larger units necessary for ships of great size the gas engine in its present form appears to be wholly impracticable. Steady, quiet motion, with variable speed and almost instant reverse are the requisites for such engines, and it is safe to say that a 4-cycle engine of much more than 1,000 horsepower could not be designed to meet these requirements, since the mass of the moving parts and the pressures of crankpins and journals would be enormously

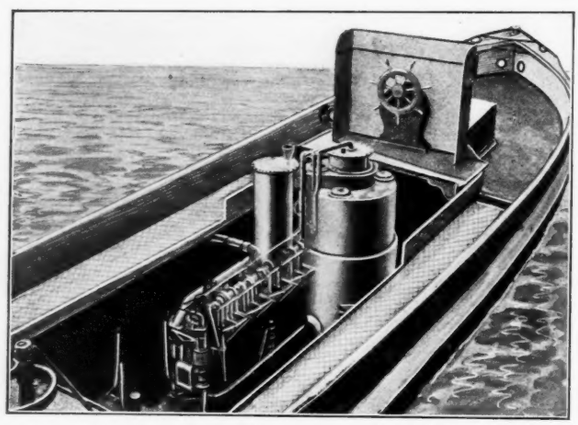


Fig. 6. Producer and Engine Installed in Boat.

high. The weight of the reciprocating parts would prevent effective balancing and the piston speed should be greater than feasible in such sizes to prevent the gases from cooling off before their heat could be transmitted into work. An engine of 1,000 horsepower has meanwhile been built by Messrs. Wm. Beardmore & Co., Glasgow, and is being installed in the former steamer *Earl*, whose old engines were removed.

M. Capitaine has experimented with a system similar in principle to the so-called free-piston engine of historic fame, which has now become entirely obsolete in stationary practice. He proposes the construction shown in Fig. 7 where there are two pistons running against each other, connected to swinging levers *D* and these levers connected to the oscillating disc *F* which runs freely on the engine shaft during the outstroke of the pistons, but is clutched to it in the

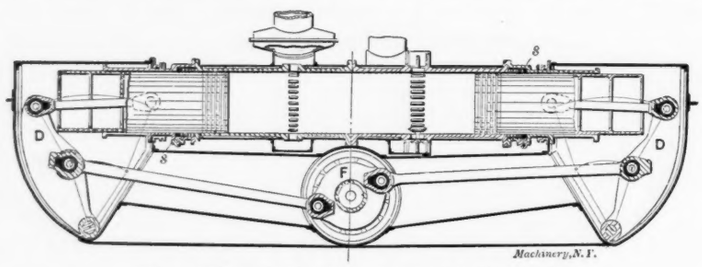


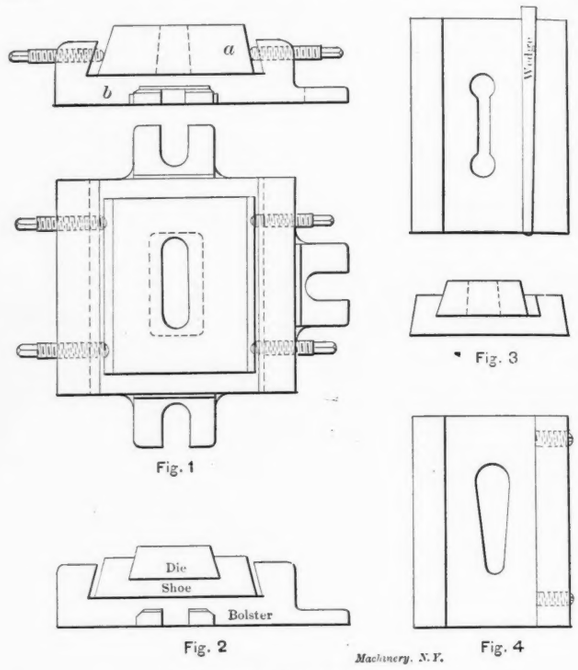
Fig. 7. Marine Engine Design Proposed by M. Capitaine.

return stroke. The cylinders and all moving parts are to be built in an air-tight chamber, the pressure in which is kept at about 45 pounds. The gas inlet and outlet is effected by slotted holes as generally used on 2-cycle engines. It is believed that the perfect balancing of this engine will make high piston speeds possible and the weight of the reciprocating parts can therefore be reduced and more power for a given weight of engine can be obtained. It would go beyond the limit of this narrative to describe the details of this engine until they are proved a practical success. So far they have only proved the correctness of theory in a 20-horsepower model engine.

PUNCH AND DIE WORK.—1.

E. R. MARKHAM.

Under the head of punch and die work is generally included all the various tools used in blanking pieces from the commercial stock; bending stock to shape; drawing out articles from sheet stock; and all the different operations performed with punching, drawing and forming presses. The most common form of tools to be considered is the dies used for blanking articles from sheet stock, called blanking dies.



Various Methods of Holding Dies.

A set of blanking dies consists of a male die, or punch, as it is generally termed, and a female die, or die block. These terms are generally abbreviated and the set is called a punch and die.

Blanking dies are generally considered as belonging to one of three classes: First, plain (or simple) dies; second, gang dies; and third, compound dies.

When punches and dies are used in a "punch" press, and are to constitute a part of the regular equipment of the shop they are held in suitable permanent fixtures. Dies are held in position on the bed of the press by means of a holdfast, the name of which differs in different shops. Some of the more common names are chair, chuck, bolster, and die holder. Dies large enough to warrant it are clamped to the bed of the press, thus doing away with the necessity for holders. Dies are fastened in place in the die holder by several methods, the most common of which is by means of screws, as shown in Fig. 1, in which *a* is the die and *b* the holder. Having screws on both sides it is an easy matter to adjust the die, loosening the screws on one side and forcing it over by those on the opposite side

When the die is small, it is generally held in a shoe, as shown in Fig. 2. The manner of fastening the shoe depends on the preference of the designer. In some shops the shoe is dovetailed as shown, the angle being 10 degrees to 15 degrees from a right angle; or, in other words, it is 80 degrees to 75 degrees with the bottom. The slot is made somewhat tapering. The die is given a corresponding taper and angle on its sides and, to fasten in position, it is driven securely in place. The amount of taper given the slot in the shoe must not be great or the die will jar loose when in use. A taper of one-half inch per foot of length answers nicely.

In other shops the shoe is made with a groove, as described above, only it is from ¼ to ⅜-inch wider than the dies, which are held in place by means of a taper key or wedge, as shown in Fig. 3. When making this form it is

necessary to make the dies of equal width on their ends. This method does not entail so great a degree of accuracy when machining the die block.

A third method consists in making a shoe having the back of slot planed at the angle mentioned, while the front wall is made square with the bottom, the die being held with set-screws, as shown in Fig. 4. If this form is used, care must be exercised when laying out screw holes that they do not come in line with the screws in the bolster when the shoe is in its proper place; and, again, the screws must not press on any portion of the die immediately in line with the opening,

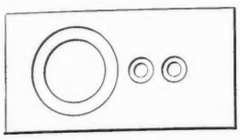


Fig. 5

A Case where a Bushed Die is best Used.

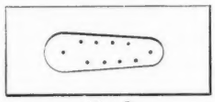


Fig. 6

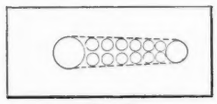


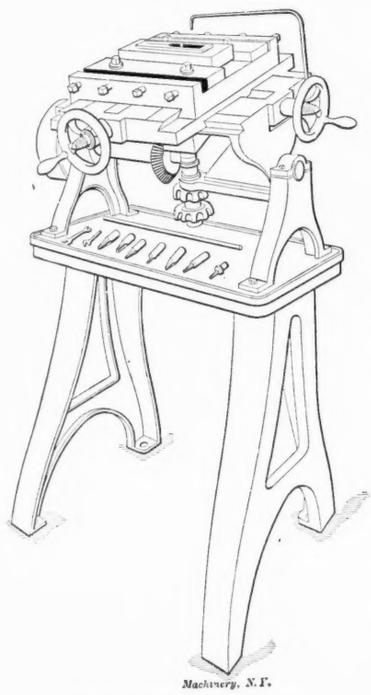
Fig. 7

Machinery, N.Y.

Working Out the Stock in a Solid Die.

or it will be closed somewhat when pressure is applied to the screws. Fig. 4 shows the screws pressing on the solid portion of the die.

Dies which are fastened in bolsters without using a shoe must have their sides machined at an angle, as in Fig. 1, to prevent them lifting from the strain incident to removing the punch when it has pierced the stock. The angle should be from 10 degrees to 15 degrees, some mechanics claiming best results with 20 degrees. The latter, however, seems greater than there is any necessity for on ordinary work.



Machinery, N.Y.

Fig. 8. A Die Milling Machine.

For most work the stock used in making punches and dies should be a good quality of tool steel. A die that has cost from 5 dollars to 100 dollars for labor is as liable to crack when hardening as though the same steel had been made into any other form of tool; and in fact its shape and irregular thickness of stock at various points, together with numerous sharp corners that are liable to be present, make a tool that requires extreme care in handling when hardening Now a good grade of tool steel, free from harmful impurities, is less liable to crack than an inferior grade, and the slight difference in cost is offset many times by the cost of labor in its construction.

The writer would not be understood by the above as necessarily advocating the use of a *high-priced* steel for this class of work; simply a *good* quality of steel, low in percentage of those impurities which cause trouble when the steel is hardened. When we speak of good, reliable steels, we do not necessarily mean high-priced steel.

The writer was connected with a manufacturing concern at one time where from six to ten dies were made each day; all of them being made of a good grade of open-hearth machinery steel that cost less than 3 cents per pound. The steel contained 60 points carbon (0.6 per cent).

The reason for using this grade of steel was that we had plenty of it, as it was bought in the billet many tons at a time for another purpose, and in cutting up and forging quantities of the stock were left as scrap which could not be utilized for anything else. Most of the work done was job work and there was no surety of a second order. The dies were generally in good condition when the order was completed, and in many cases answered for many subsequent orders. It was necessary, however, in order to get best results, to harden them by the pack hardening process, which entirely eliminated the possibility of their cracking and gave them a durability far in excess of many dies made from tool steel hardened by the ordinary method. On general principles, however, I should not advocate the use of any but a good grade of tool steel for this work. If those in charge have had an experience that enables them to discriminate, they will be able to judge when a low-grade steel like the one mentioned will answer.

If best results are desired when hardening, the steel should be annealed after the outer surface of the piece has been removed and the opening blocked out somewhere near to shape.

In all shop operations true economy should always be practiced and many times this may be done by a saving of tool steel. If a die is like Fig. 5, a saving may be effected by making the body of cast iron and inserting disks of tool steel; and if we wish at any time to make a new die, we simply make the disks, and if ordinary care is taken the holes will be concentric and consequently the proper distance apart, so there will be no necessity of altering the location of the punches, as might be the case if a die made of a solid piece was hardened.

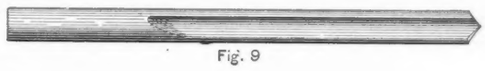
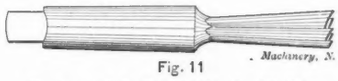


Fig. 9

Fig. 10



Machinery, N.Y.

Fig. 11

Tools used in Die Making by Machinery.

When a number of dies are to be made to fit the same holder, they may be planed to size in the bar and then cut apart by means of the cold-sawing machine. It will be necessary to plane the finish side of dies that must fit a shoe of the style shown in Fig. 2 as one end must be wider than the other. This may be effected very readily by having a strip of cast iron planed to the proper taper to place the die on when planing or milling.

The face of the die must be smooth in order that the outline traced on it may closely correspond to the templet. If the surface is a succession of ridges, the scriber will not closely follow the edges of the pattern, and the figure traced will be larger than desired.

Most up-to-date shops keep a record of the cost of every tool made, as well as any peculiarities of the finished tool. This necessarily is a record of each man's work, its cost and condition. The toolmaker who is desirous of advancement should keep the cost of articles he makes as low as is consistent with good work, and the quality as high as is consistent with reasonable cost of an article of the kind.

After the face has been made smooth by planing, grinding or filing, the surface may be coated with the blue vitrol solution, or it may be heated until it assumes a distinct straw or blue color, and the outline of the piece to be punched laid out.

If the die is what is known as a solid die, that is, made from one piece of stock, it may be laid off and prick-punched as in Fig. 6, after which holes may be drilled, leaving the face of the die as in Fig. 7, after which the core may be removed. When drilling for the opening, first drill any portions which are to be left circular or semi-circular in shape. These are then reamed from the opposite side with a taper reamer that will give the desired amount of clearance.

When drilling to remove the core mentioned, some toolmakers use drills of a size that break into the next hole. After drilling way around the core drops out of its own accord. If this method is adopted, best results follow the use of the straightway drill, Fig. 9. Others drill with drills of the size of the pilot of a counterbore and after drilling all the

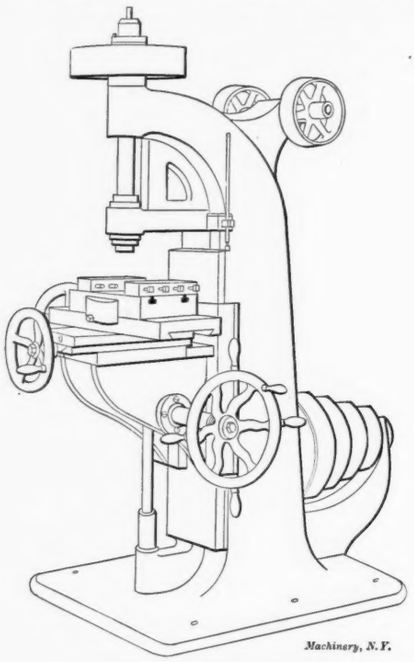
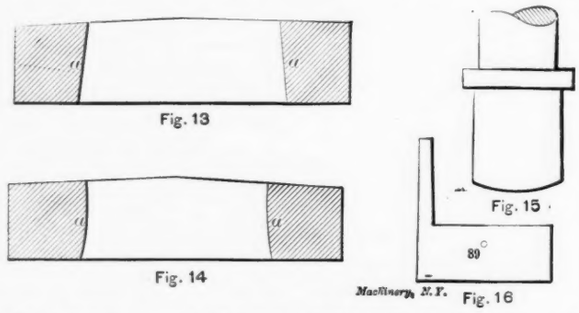


Fig. 12. A Die Sinking Machine.

holes the counterbore is run through. Of course, it is understood that in laying off for the holes they are located so the counterbore breaks into the next hole.

A third method consists of laying off and drilling holes so there is a little stock between the holes after drilling, which is broken out by means of a drift driven in from each side until the cuts meet. In this way the stock is cut away and the core removed.

After taking out the core the die may be placed in a die milling machine, or a die sinking machine and by the use of



Figs. 13 and 14. Correct and Incorrect Relief. Fig. 15. Punch Crowned for Stiff Stock. Fig. 16. Templet for Relief.

a tapered milling cutter the stock may be removed and the desired angle of clearance given the walls of the hole. The angle of clearance necessary for best results cannot be arbitrarily stated, but varies according to the character of the work to be done with the die. In the absence of either of the milling machines mentioned, a universal or a hand miller may be used. There are various slotting devices which may be attached to universal milling machines which are used advantageously on work of this character. During the past few years several vertical filing machines have been placed on the market which are recommended highly for the purpose of working the openings of dies to shape.

The writer is not in a position to speak positively regarding these machines; he was at one time with a concern employing quite a number of skillful die makers. One of these machines was installed and for some reason failed to give as good results as claimed for it. In fact, a die could be filed out by hand in less time than by machine and the hand work was fully as satisfactory. However, had the machine been introduced into a shop where less skilled labor was employed to do the same class of work, the results might have been in favor of the machine. The men employed in the die room mentioned were all very proficient in that particular branch of work, and I realize that the machine was up against a hard proposition, so I would not be understood as condemning it, but simply give our experience with it. If a die milling machine, Fig. 8, is used, the form of taper milling cutter shown in Fig. 10 is employed. As the milling cutter is driven by a spindle beneath the die, the cutting portion extending up through the opening, with the face of die uppermost, the small part of the cutting portion should be at the end of the cutter.

If a die-sinking machine, Fig. 12, is used, a cutter like Fig. 11 is used. After working the opening to shape and size as nearly as possible with the milling cutter, it may be finished by filing. According to the writer's experience there never was a time when skillful die makers were in demand more than at the present time; the fact that so few apprentices are taught the use of hand-operated tools to an extent that makes them skillful in their use creates a condition that is favorable to those who have been fortunate enough to have acquired skill in the use of the chisel and file. Not that their use is to be advocated where it can be dispensed with, but there is, and always will be, a demand for men skilled in their use.

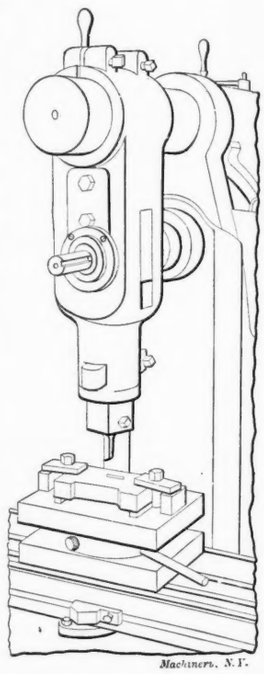


Fig. 17. Die Slotting Attachment for Milling Machine.

When finishing the opening to shape and size it is necessary to get the desired clearance and to have the walls of the opening straight, as at *a a* in Fig. 13, rather than rounding as represented at *a a* in Fig. 14.

The amount of clearance differs for various work and ranges from one-quarter to three degrees. The greater amount is seldom given unless it is necesssary that the blank fall from the die each time one is punched. Another instance where it is desirable to give excessive clearance is where a punch with a crowning face, as in Fig. 15, is used for punching stiff stock.

When a milling machine with a slotting attachment, Fig. 17, is used, sharp corners may be cut to the line, as may certain irregular surfaces which could not be shaped with milling cutters. Of course, it would be necessary to have cutting tools of the proper shape to machine the forms men-

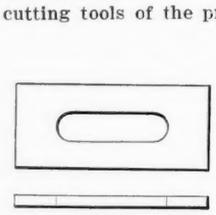


Fig. 18. A Product for which the Punch should have a Shear.

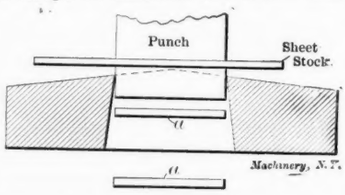


Fig. 19. A Case where the Shear should be on the Die.

tioned, the advisability of making which would depend on whether it would be cheaper to make the necessary tools and to do the machining, or file to the desired shape.

A fixture known as a die shaper, whose action resembles the slotting device described above, is made to attach to a milling machine and works the same as the other attachment.

In order to gage the angle of clearance it is advisable to have angle gages. Several of these may be made and kept in

the tool chest and should be of the more common angles used. They may be of the form shown in Fig. 16, with the angle stamped on the heavier portion.

The cutting faces of dies are given *shear* for the same reason that the teeth of milling machine cutters are made spiraling. The shear makes it possible to cut the blank from the sheet with less expenditure of power; it also reduces the strain on the die and punch. While it is customary to shear the face of the die when possible, there are instances when it is advisable to leave the face of the die flat and shear the punch.

The *shear* is given the *punch* when the stock around the hole is the desired product and the stock removed is scrap, as in Fig. 18. The face of die is sheared when the portion pressed through the die is the product, as at *a a* in Fig. 19, which also illustrates the shear of the die.

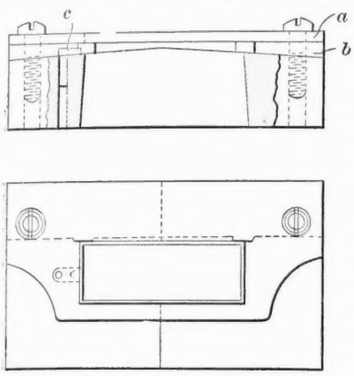


Fig. 20. Example of a Stripping Plate.

The amount of shear necessary to give a die to obtain best results depends a great deal on the thickness of the stock to be punched, and also on the length of the piece to be removed, and on the power of the press.

Shear of a die usually commences at the center and extends toward each end, as in Fig. 19, the punch being left flat on its face. When the punch descends, the cut commences at the highest point of the die, which is in the center, and continues toward each end. The portion at the center will have been removed from the stock before the cut has progressed very far toward the ends, and in this manner the cut is distributed over the length of the piece, reducing the strain on the press and tools.

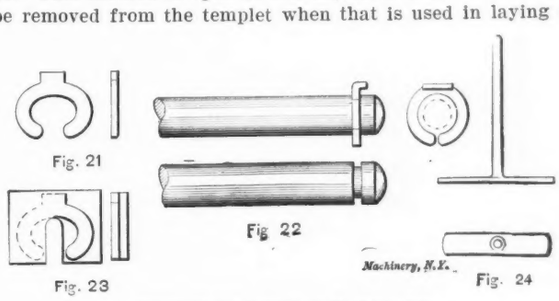
The diemaker, if he works to drawings furnished him by the draftsman, makes the thickness of die and length of punch to correspond with dimensions. However, it is customary in shops where few dies are made and no draftsman is employed, to give the diemaker or toolmaker an idea of the shape and dimensions wanted, or possibly a templet, and he is obliged to go ahead and "work out his own solution." In such cases the workman must first find the dimensions of the press to be used, the distance from the bed to the ram, the length of stroke of the ram, the amount the ram may be adjusted, the thickness of the bolster, and particulars about any shoes that are to be used. These things should be carefully set down and kept where the workman may have access to them at any time. If there are several presses, each should be marked and the dimensions of each carefully recorded, according to the work of the individual machine. If this precaution is followed and the dimensions taken into consideration when machining the die and punch, there need be none of the trouble sometimes experienced, such as a die too thick or a punch too long, or the reverse, for the press in which they are to be used. To a man working in a shop where due attention is given to every detail, such examples of carelessness may seem "far fetched"; but nevertheless, these things do happen.

When articles are punched from sheet stock or in fact from any stock where scrap is around the punch, the stock will be carried upward when the punch ascends, unless some device is furnished to prevent its doing so. Fig. 20 shows an arrangement (*a*) called a stripper, or stripping plate, the opening in this being a trifle larger than the punch. The stripper plate must be securely fastened to the die, or the die holder, and must be stiff enough to prevent its springing when in use. Between the stripper and the die (at *b*) is a guide against which the stock being operated on rests and it determines the amount of scrap at the back edge of the sheet. The stripper is made of a thickness that insures the space between the die and stripper being somewhat greater than the thickness of the stock used; in fact the space must be sufficient to allow the stock to move along easily even when the surface is made somewhat irregular by the operation of punching. At *c* is a guide pin or stop against which the stock is placed to determine the endwise setting.

When dies are made for producing pieces that must be of a given size and shape it is necessary to have a piece of the same shape and size to work to; this is called a templet. At times it requires a considerable degree of skill to make a templet that will answer for the work in hand. The writer recalls an instance when as a young toolmaker he was given the job of making a templet of the design shown in Fig. 21. After blanking and turning the ear at the top, the piece was to be closed on a groove in an axle, as shown in Fig. 22. After closing, the outside of the washer was supposed to run about true. The die was made to the templet and it was found less difficult to make the die than the templet. In this instance it was necessary to make two pieces of the desired shape exactly alike, one of which was closed on the model axle and tested. The points that were not right were located on the one that had not been closed up. Then others were laid out from it, due allowance being made for the imperfections of the first. When making, two pieces of stock were placed together and one half was worked to the laying out lines as in Fig. 23. After the other half had been blocked out somewhere near the line the pieces were reversed and each half that had been blocked out was finished to the finished half, as shown. In this way the ends were exactly alike and the two being machined, or filed together, were of course, alike. When one was turned or closed on the axle and was found correct the other answered for the templet to be used in laying out the die and afterward to fit the opening, too.

While the example related was comparatively simple, it did not appear altogether simple to one not accustomed to that class of work, and it serves to illustrate the idea brought out.

In order that templets may be easily handled it is customary to attach some form of handle to them, which is sometimes done by drilling and tapping a hole in the templet, and cutting a short thread on a piece of wire which is screwed into the tapped hole. Another common method is to atttach a piece of wire by means of a drop of solder, as shown in Fig. 24. This method is open to the objection that the wire must be removed from the templet when that is used in laying out



Templets and Means for Holding them.

the punch, as it is necessary when the templet differs in shape on two edges to lay opposite sides of the templet against punch and die. This will be considered again under punches.

* * *

A newspaper item says that James Lick, the San Francisco millionaire who founded the observatory bearing his name, was very particular about orders being obeyed strictly. It is alleged that whenever he took anyone into his service on his estate the applicant was asked to plant a tree upside down, the roots in the air and the branches in the ground. If the unfortunate made any protest he was sent away at once for the test was one to show whether he would obey orders strictly without questioning them. The foregoing no doubt is an example of the tommyrot about successful men that certain writers try to impress on the younger generation as good instruction. As a matter of fact a man who would not question such a foolish or crazy procedure as this would not be worth his salt, unless he was "onto the game." The value of an employee is determined not only by his willingness to obey orders, but by his ability to execute them with some intelligence as well, and not as a mere automaton.

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MACHINERY

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DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

JULY, 1906.

PAID CIRCULATION FOR JUNE, 1906,—22,295 COPIES.

MACHINERY is published in four editions. The practical work of the shop, is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

EDITORIAL CHANGE.

Lester G. French, for nine years editor of MACHINERY, has resigned with a view to taking up a line of work of his own. His plans include the publication of a series of technical books, the first of which will be a treatise on steam turbines, which he has had in preparation for several months. His address for the present will be Brattleboro, Vt.

The people who know Mr. French best and appreciate him most highly are those who have worked with him daily in this office during the past nine years; but outside of this circle is a far wider one comprising those who know him in his editorial capacity and who will join us in our regrets at his departure and in wishing him good luck in the future.

Fred E. Rogers, for nearly eight years associate editor of MACHINERY, will continue in Mr. French's position.

* * *

ALCOHOL IN THE ARTS.

The bill giving manufacturers and the general public denaturized alcohol, for industrial purposes, entirely free of tax, and upon which comment will be found in another part of the Engineering Edition, is a broad and liberal measure. It proposes that domestic alcohol may be withdrawn from bond, without the payment of an internal revenue tax, for use in the arts and industries and for fuel, light and power, provided the alcohol shall have been mixed, in the presence and under the direction of an authorized government officer, with methyl alcohol or other denaturizing material. It provides, however, that this latter may be of a character suited to the use for which the alcohol is withdrawn, so that no one requiring alcohol in the manufacture of his products will be hampered or restricted in any way by the requirements of the denaturizing process. The alcohol is to be treated in bonded warehouses especially designated for denaturizing purposes only.

Although a severe penalty is imposed for attempting to recover, by distillation or otherwise, pure alcohol from denaturized alcohol, there is a provision whereby alcohol pressed out or evaporated from products during their manufacture may be recovered and restored to a condition suitable for use again in the manufacturing process.

While there is a probability that this measure will give a great impetus to the manufacture of many lines of products, the particular use that the readers of MACHINERY will be interested in is in connection with the internal combustion engine. The aspect is a foreboding one for the small steam engine, which has already been largely replaced by the gasoline and gas engine and may have to further succumb under the pressure of the alcohol motor.

* * *

In an article this month by our contributor, Mr. Fairfield, is a series of views of the successive operations required for making a simple machine part. These views probably come as near to the moving picture method of representing progressive motion as is feasible under the conditions. None of the operations shown is unusual or unfamiliar to most of our readers. Apart from the attractiveness that illustrations of progressive motion naturally have, however, these views, though commonplace, represent good shop practice and are well worth careful study. They will at least serve to impress the fact that a large number of steps or elementary operations are required in making even so simple a machine part as a wormwheel. Thirty-six illustrations were necessary to give a fair idea of these operations; and it is only by a detailed study of each individual one, in the manufacture of wormgears or of any other part of a machine, that the cost of machine work can be reduced to its lowest limit. The most successful attempts at cost reduction have been made through a study of the time required and the methods to be used for the most minute subdivisions of manufacturing processes, even to the extent of using a stop watch for determining such elements as the time required to clamp a tool in the tool post or to release the spindle of a tail stock. Having data upon such elements, the skillful director of machine work can, by adding one element to another, build up his estimate on a scientific basis; whereas if the estimate is based upon the aggregate time required to perform several steps in an operation upon a piece, the results cannot be arrived at with anything like the same degree of certainty.

* * *

FIRE PROTECTION.

The new shops of the Western Electric Co., Hawthorne, Ill., are models in design and arrangement and the whole plant indicates extended and careful preliminary planning. Not the least feature of interest is the unusually complete provision against loss from fire. There is an ample water supply, the grounds and buildings are protected by hydrants and sprinklers, and all the usual apparatus for fire fighting has been provided. Beyond this, however, precautions have been taken to have a thoroughly trained and competent force of firemen ready to render instant service and a special watchman makes it his duty to inspect the various departments and operations in order to detect possible sources of conflagration.

Manufacturers are rapidly coming to take a more rational view of fire protection as related to insurance questions. Instead of paying insurance companies exorbitant sums for the protection of fire traps, they are now learning to provide the real protection themselves and pay the insurance company a much smaller premium as an extra safeguard against what in their case is the remote possibility of destruction by fire through some very unusual cause. It was recently stated in the columns of *Insurance Engineering* that during a period of 44 years the stock fire insurance companies of the United States have received premiums aggregating over $3,500,000,000. We should be a thriftless and short-sighted nation if we were to allow such a condition to exist indefinitely as is represented by this enormous amount, paid to companies for protection, when that protection could have been provided *in the main* by the property owners themselves for a sum insignificant compared with that represented by the above. This is, in fact, the basis on which the mutual factory fire companies are organized.

* * *

An appreciative reader says of the shop receipts and formulas: "Your receipt column in MACHINERY is a grand good thing and I hope it will continue until everything a white man can make use of is there." The column will continue as long as its readers are enough interested to send us their tried and true recipes for publication.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Much difficulty is generally experienced in getting paint to adhere firmly to galvanized iron, and various experiments are resorted to to overcome the trouble. The government has adopted a mode of procedure that seems to be satisfactory. Their specifications compel the use of vinegar for washing the surface preparatory to painting. This roughens or corrodes the surface, and gives the paint better adhesion.—*Railway Master Mechanic.*

A rock crusher is being built by the Power and Mining Machinery Co., Cudahy, Wis., which, because of its great size and capacity, is to be classed with the largest, and perhaps as the largest of its kind. The crusher is to weigh 100 tons and is expected to eat its own weight in rock every 8 4/7 minutes, having a capacity for crushing 700 tons of rock an hour. The crusher will be installed at Little Falls, New York, and the crushed stone will be used for ballast, railroad and concrete work. Here, as in successful manufacturing industries of to-day, the by-products are to be utilized. All of the dust or fine material accruing from the crushing of the stone is to be used for making cement bricks.

A good method of estimating the horsepower that can be transmitted by a wire rope drive, says a writer in *Ice and Refrigeration* is to multiply the speed of the rope in feet per minute by three times the span in feet and multiply this result by the weight of the rope in pounds per foot; this product divided by 33,000 gives a conservative figure for the average horsepower transmitted by wire rope drive. Expressed as a formula it would be as follows:

$$HP = \frac{3SVW}{33{,}000}, \text{ in which}$$

V = speed of rope in feet per minute;
S = span, in feet;
W = weight of rope, in pounds per foot.

The position occupied by the mechanical stoker is clearly outlined in a bulletin of the Iowa State College Engineering Experiment Station, the bulletin being notes on power generation in Iowa. In regard to tests of mechanical stokers the report says that two things to be desired by all steam plant owners and manufacturers in the use of coal and steam generators are economy and smokelessness. Intelligent hand firing is the best agency yet known for securing these but unfortunately intelligent firemen are not easily obtained or retained and in large plants their cost may be prohibitive as compared with the mechanical stoker. Consequently mechanical stokers have been developed in many localities where they have met the demands of economy and *sometimes* of smokelessness.

The large locomotives that have come into common use on most trunk line railroads have made necessary a great many changes in machine shop equipment, as we all know. A case in point is the size and power of the wheel press. A few years ago a wheel press of 300 tons capacity was considered ample for almost any railroad shop, for with the size of axles then in use it was very rare that the ultimate capacity of the press would ever be required, but with increase of locomotive dimensions came the jump from a 7-inch axle to axles 10 inches or more in diameter, and this meant much greater pressure for wheel fits. One of the interesting new tools installed in the Sayre shops of the Lehigh Valley Railroad is a Bethlehem wheel press of unusual design having a capacity of 500 tons. The cylinder is a steel casting cradled in a cast iron housing. The resistance or sliding head is shifted longitudinally by means of two large screws at the top and bottom, these being driven by power.

The State engineering experiment station organized in connection with the University of Illinois, Urbana, has undertaken important work at various times for the benefit of the manufacturing and engineering interests of the State of Illinois. A series of tests is now being arranged upon Illinois coals. Their efficiency is to be determined, not only by chemical analysis and calorimeter tests, but the fuel is also to be tried out under power plant boilers, in gas producers and in residence heating boilers. This is the first time, so far as we know, that any attempt has been made to study fuel economy in the latter type of boiler, it generally being supposed that house heating plants have no economy at all, unless it be in a negative direction. An advisory committee is co-operating with the experiment station, made up from representatives of different engineering societies of the West and assistance will also be rendered by the State Geological Survey.

The Iowa State College Engineering Experiment Station recently made a test on a hard coal producer gas engine in the city electric light plant at Algona, Iowa. A three-cylinder vertical Fairbanks-Morse gas engine, using gas generated from anthracite pea coal in a suction producer was the subject of the test. The unit is rated at 150 brake horsepower at 250 revolutions per minute and was guaranteed to give 1 brake horsepower for 1½ pound of anthracite pea coal for all loads above 75 horsepower. The results of the test show that at 250 revolutions per minute and a brake load of 40.1 horsepower 1.511 pound of coal was required per brake horsepower; at 250 revolutions per minute 82.7 brake horsepower required 1.157 pound; and at 250 revolutions per minute 156.9 horsepower required the consumption of 0.999 pound of coal per brake horsepower. The cost of fuel was $6.00 per ton, thus making the minimum cost per brake horsepower hour $0.00299.

One of the great drawbacks to ballooning has been the cost and difficulty of manufacturing hydrogen gas. Consul-General Frank H. Mason, of Paris, France, says in a recent consular report that a new process for the manufacture of hydrate of calcium has been developed in France by Mr. G. F. Joubert, which product, because of its convenience in making hydrogen gas, will likely have an important influence on that sport or business in the future. The new form of hydrate of calcium is called "hydrolithe" and when pure 1 kilogram will generate 1,150 liters of hydrogen gas. It is safe and easy to handle, can be used for generating gas wherever water can be obtained, and for long flights can be carried as ballast instead of sand, and employed at will for refilling the balloon, which may thus be kept in flight almost indefinitely. As an illustration of the economy of weight that has been accomplished by the substitution of hydrolithe for the purposes of military balloon service, it may be stated that an ordinary field balloon contains, when inflated, about 500 cubic meters of gas, the generation of which by the means hitherto employed requires the employment of materials and apparatus which fill three wagons, each one of which weighs when loaded 3½ tons, and requires in a campaign to be drawn by six horses. All this cumbrous and costly equipment can now be replaced by a two-horse wagon carrying a ton of hydrolithe, which, with the addition of water that can be obtained anywhere, supplies instantly and in controllable quantities whatever gas may be required.

The General Electric Co. are building a type of transformer having thin corrugated shells. The shells are made of sheet iron about 1/32 inch thick, corrugated longitudinally, the corrugations being 3 or 4 inches deep and 2 or 3 or 4 inches pitch according to the size and style of the transformer. The shells are built up by fusing or welding together the previously corrugated sheets by means of an electric arc, using a carbon pencil held in a suitable insulated handle. The pencil is made the negative electrode so as to avoid carbonizing the sheets and making them brittle at the joints. The edges of the sheets are not butted together but are laid together sideways and the two adjacent edges are melted together with the carbon pencil, which becomes incandescent at the point the moment the circuit is completed. It is claimed that the joint is as

strong or stronger than any other part. After the sheets are fastened together in the form of a hollow square they are clamped in shape and taken to the foundry and a base cast around, thus making an absolutely oil-tight structure which is very light and has a high radiating capacity.

According to the *Times Engineering* Supplement, an English patent (No. 12,898 of 1905) has been granted to Mr. L. K. Clark, of the St. Louis Car Company, St. Louis, Mo., U. S. A., for a neat improvement in exhaust silencers or mufflers for two or four-cylinder engines. The silencer consists of two casings or chambers, the one enclosed within the other, but each having approximately the same cubic capacity or volume. In a four-cylinder engine, cylinders 1 and 4 are connected to the outer of the two chambers and cylinders 2 and 3 to the inner chamber. Each chamber is fitted with a series of outlet pipes in such a way that the outlet pipes from the inner chamber fit concentrically within the outlet pipes from the outer chamber. By the arrangement of connection to cylinders the exhaust is discharged alternately to the two chambers, and the outflow from the one chamber in its passage by or through the outlet pipes of the other chamber acts in the manner of an ejector to produce a partial vacuum in the other chamber.

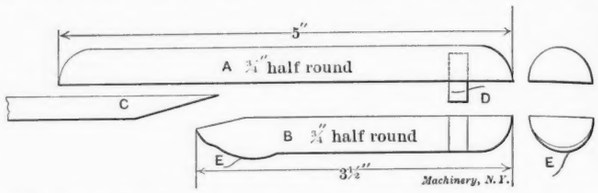
We occasionally receive from the Goldschmidt Thermit Co., 43 Exchange Place, N. Y., descriptions of interesting repair jobs that have been accomplished in welding together broken parts of machinery by the use of thermit. One of the recent repairs was made in San Francisco just previous to the earthquake upon a large forged steel dredge bucket arm measuring 2 inches thick by 12½ inches wide. This was broken squarely off and was effectually repaired by the thermit process. Anticipating the question which naturally arises as to the strength and permanency of Thermit welds, the Goldschmidt Co. had tests conducted at the works of the Fore River Ship Building Co., Quincy, Mass., to throw some light upon this point. Bars of rolled steel 2 inches by 4½ inches were drilled, broken and welded with Thermit and standard test bars cut from the center of the weld. As a basis of comparison test bars were also cut from the unwelded portion of the steel. The following is a condensed report of the tests.

Description.	Elastic Limit.	Tensile Strength.
Weld	32,000	59,000
Stock	38,500	60,500
Weld	33,700	61,800
Stock	36,850	63,400

One of the great widely-advertised scenic features of the Denver & Rio Grande Railroad is the Royal Gorge in the Grand Canyon of the Arkansas in Colorado. This gorge in one place is about 50 feet wide at the bottom and 230 feet in width at the top, while the height of the walls of the gorge is about one-half mile. On account of the narrowness of the gorge there was not room to construct the railway in one place and leave room for the rushing waters, so the novel expedient of building a hanging longitudinal bridge was adopted, it being supported by I-beam trusses set into the rocks on either side and meeting in the center over the stream at an angle like the rafters of a roof. A suspension bridge is now being built across the top of the canyon, says the *Technical World*, which will be 230 feet long and 2,550 feet above the railroad track, making it one of the highest if not the highest bridge in the world. A novel feature of this bridge which, of course, is built almost entirely for the scenic features, is that the floor will be made of plate glass 1½ inch thick set in steel framework through which objects below can be seen. Tourists coming over the Denver & Rio Grande Railroad will be transported to the bridge half a mile above by a roundabout electric railway 12 miles long.

TO REMOVE DENTS FROM GUN BARRELS.

The blacksmith in the rural districts is often called upon to remove bad dents from shotgun barrels that have fallen upon stones or met with some similar accident. Mr. E. C. Johnson describes a simple tool in the *American Blacksmith* for removing such dents. The dimensions are for a 12-gage gun. To make this tool take two pieces of ¾-inch half-round iron, one piece *B* 3½ inches long and the other piece *A* five inches long. Put them together and file them down until they are slack at the muzzle of the barrel. A 3/16-inch rivet is set in the flat side of the long piece *A* about ½ inch from the end. In the short piece a hole is drilled, in which the rivet will fit loosely, to keep the pieces together in the barrel. The piece *B* is filed oval for the greater part of its length leaving the



hump *E*, and the end is beveled, for the spreader or wedge *C*. The spreader is made about 18 inches long which is convenient for most jobs. The tool is placed in the barrel with the piece *B* and hump *E* next to the dent and the spreader *C*, well oiled, is inserted. The dent is heated with a hot iron and a few blows on the spreader with a light hammer do the trick. This tool is very effective on even the more badly dented barrels, though ordinary precaution must, of course, be exercised to prevent the possible bulging of the barrel.

SUPERIOR EFFICIENCY OF HIGH-SPEED STEEL PUNCHES

Engineering Magazine, May, 1906.

The ordinary punch, as is well known, usually gives out by collapsing or breaking off after the edge has become somewhat dulled. The increasing force required to drive the punch through the metal rapidly increases the molecular fatigue or intensifies already existing internal strains until the endurance limit is reached. The limit in high-speed steel is not very well established, but is certainly much beyond that of carbon steel of the best kind. Objection has been made to high-speed punches that, like drills, they are too brittle. The same answer, however, applies, namely, that proper annealing, to give the requisite toughness, obviates the danger of breakage, or reduces it to a minimum. Small-sized punches, however, if working through thick, high-carbon steel, are difficult to temper to just the point at which they will have the required hardness and at the same time be tough enough to stand up. For this kind of work, where the holes are under, say ½-inch, the results with carbon punches seem to be about as satisfactory as can be obtained with high-speed tools, unless the stock is relatively thin. But in all the larger sizes, and in the case of tools for broaching holes in malleable iron, there can be no mistaking the higher efficiency of high-speed punches. A ⅞-inch punch, for instance, punches about 56,000 holes in a ⅜-inch channel iron. The life of a carbon steel punch is about 6,000 holes. This is in the ratio, approximately, of nine to one, a ratio which holds good for nearly all punching operations except as already pointed out.

ENGINEERING REPORTS AS ADVERTISEMENTS.

Engineering Record, April 28, 1906.

The consulting engineer who has worked up a good business without having seen at least one of his reports used for advertising purposes or bolstering bond issues is to be congratulated. The lyric star whose name is given to cigars and the professional "society" chaperon who furnishes a recommendation for tooth powder are paid for the use of their names in advertising matter; nobody is deceived as to the value of the recommendation in such a case. But an engineer who reports confidentially on some engineering appliance or process is rightly disturbed to find extracts from his report of a favorable character used for advertising purposes, while those of an unfavorable character are withheld. This misuse of his report may make it appear that the engineer endorses the appliances or process when, in reality, quite the contrary may be true. The act is very different from the mere abstracting of certain parts of a report in preference to its publication as a whole. The interested parties who distort such a document really commit an act of fraud, for it brings to the public eye certain

things ostensibly supported by authority which, in point of fact, does not exist. Every disinterested man should frown upon this practice, not only for the moral question involved, but for the injury to the engineer who is thus misrepresented.

As an instance of what has been done, take the case of a manufacturer of steam appliances who made a contract with a mill for the remodeling of a boiler plant and the attachment of certain apparatus for the alleged better combustion of the coal, and made a guarantee that he would save on the total quantity of coal burned 30 per cent of the cost of his present fuel; the decision as to the fulfillment of the guarantee being left to an expert who was to test the fuel consumption both before and after the appliance was attached. The steam appliance man noticed that the fireman was inefficient. There were certain leaks about the steam plant and certain wastes that could easily be remedied; and, furthermore, the class of fuel was of an expensive character. In a word, there were opportunities to make various improvements with little or no reconstruction, that would, in themselves, secure a considerable saving in the cost of operation. The coal consumption and the cost of fuel per horse power per hour were determined by the expert, and the new appliance was attached and preparations were made for the second trial to ascertain the fulfillment of the contract. In the meantime the fuel was changed to one which was nearly as efficient, but far less expensive, some insignificant changes made in piping, and some of the fittings were changed by which the leaks and wastes spoken of were remedied, the fireman was instructed in the proper management of the boilers, all being done at the suggestion of the party who put in the appliance. Then the test was repeated. When the result had been determined it was found that the cost of fuel was not only reduced to the extent of the guarantee, but 5 per cent more! and the expert reported to his clients accordingly. The expert stated in his report the condition of the plant before the appliance was attached, and after its installation; and, furthermore, made note of the changes that had been made, and summed the whole up by stating that the aggregate saving was 35 per cent. Thereupon the steam appliance people published an extract from the expert's report to the effect that the application of the appliance had resulted in a saving of 35 per cent and conveyed the impression to the public that, upon the authority of the expert in question, the efficiency of the appliance was represented by this saving. The facts were that a large part of the improvement was produced by the single change in the kind of coal burned to one of a cheaper class and nearly the whole of the remainder was due to the improvement in firing and the prevention of wastes that were going on before that time; in point of fact, the appliance produced barely any improvement whatever.

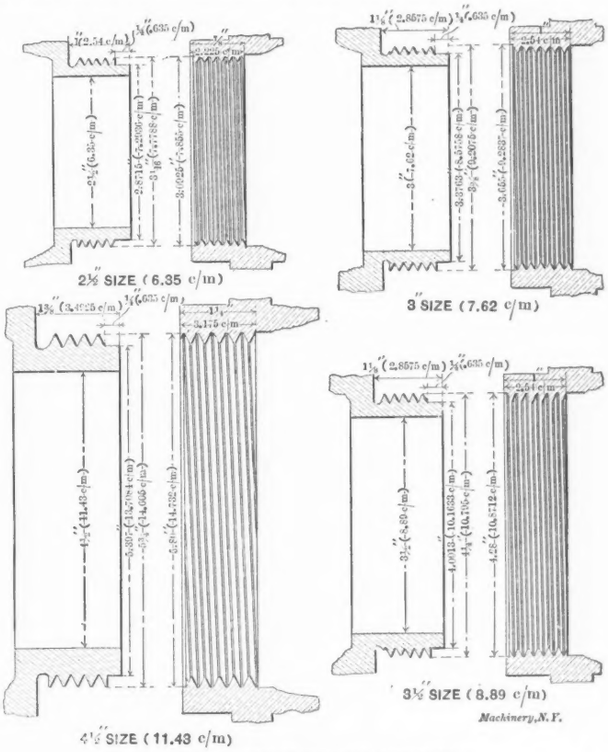
Engineers may ask how the misuse of a report can be stopped, inasmuch as the manufacturer has paid for it to use it as he sees fit. That is true only in part; he can suppress it, of course, or publish it, but he has no right to use an engineer's name to mislead the public for his own profit. It is the privilege and should be the duty of every engineer whose reports are garbled so as to mislead or deceive, to call the public attention to the fact. If the engineer fails to do so, the public will rightly conclude that he was paid to make a report with that object in view. A few exposures will be quite effective in putting a stop to this practice.

PROPOSED STANDARD HOSE COUPLING.

The importance of having standard hose couplings for all cities and towns has long been recognized but unfortunately the movement toward standardization has been very slow. There are now something over 800 sizes of hydrant nozzles in use in the United States where four or five sizes would be ample. Interchangeable standards are of most importance to towns and small cities where in the cases of destructive conflagration it is often necessary to call on neighboring cities for help and, if in such cases the hose connections will not fit the hydrants, there is little that can be done. The consequences often have been that fires have made great destruction simply because of this lack of interchangeability. A recent issue of *Insurance Engineering* shows the four standards proposed by the National Fire Protection Association's special committee, which have received the endorsement of a number of water works associations, firemen's associations, underwriters, etc. It is pointed out that the adoption of the new standards will not necessitate the discarding of the existing hydrants and hose couplings as adapters can be provided at small cost so that the old hose may be used with new couplings or new hose used with old hydrants during the period of transition. Following are the principal dimensions and other data for 2½-, 3-, 3½- and 4½-inch standards:

National Fire Protection Association Standard Hose Couplings.

	Inches.	Centimeters.
Inside diameter of hose coupling.....	2½	6.3500
Number of threads per inch, 7½.....	..	....
Blank end of male part.....	¼	.6350
Outside diameter of thread finished.....	3 1-16	7.7788
Diameter at root of thread	2.8715	7.2936
Clearance between male and female threads	.03	.0762
Total length of threaded male end.....	1.00	2.5400
Inside diameter of hose coupling.....	3	7.6200
Number of threads per inch, 6.....	..	....
Blank end on male part.....	¼	.6350
Outside diameter of thread finished.....	3⅝	9.2075
Diameter at root of thread.....	3.3763	8.5758
Clearance between male and female threads	.03	.0762
Total length of threaded male end.....	1⅛	2.8575



Proposed Standards for Hose Couplings.

Inside diameter of hose coupling.....	3½	8.8900
Number of threads per inch, 6.....	..	....
Blank end of male part.....	¼	.6350
Outside diameter of thread finished.....	4¼	10.7950
Diameter at root of thread.....	4.0013	10.1633
Clearance between male and female threads	.03	.0762
Total length of threaded male end.....	1⅛	2.8575

Sixty-degree V thread pattern 1-100 inch (0.0254 centimeter) cut off top of thread and 1-100 inch (0.0254 centimeter) left in bottom of valley. Female end to be cut ⅛ inch (0.3175 centimeter) shorter for endwise clearance. (This applies to the 2½-, 3- and 3½-inch sizes.)

	Inches.	Centimeters.
Inside diameter of hose coupling.....	4½	11.4300
Number of threads per inch, 4.....	..	....
Blank end on male part	¼	.6350
Outside diameter of thread finished.....	5¾	14.6050
Diameter at root of thread.....	5.3970	13.7084
Clearance between male and female threads	.05	.1270
Total length of threaded male end.....	1⅜	3.4925

Sixty-degree V thread pattern 2-100 inch (0.0508 centimeter) cut off top of thread and 2-100 inch (0.0508 centimeter) left in bottom of valley. Female end to be cut ⅛ (0.3175 centimeter) shorter for endwise clearance.

THE GAS TURBINE.

Power, May, 1906.

The proposition to ignite a mixture of gas and air in a tank and utilize the resulting expansion in driving a turbine runner is a highly attractive one, and the mere dilettante is disposed to enthuse over it, basing his enthusiasm on a blind faith in the ability of the real workers in this branch of engineering science to eliminate or surmount the difficulties "somehow." But when men of the class of Clerk, Lucke and Neilson give no encouragement, one's optimism sags dreadfully. Broadly, the apparent insurmountable obstacles are the high temperatures necessary to economy, the inefficiency of the expanding nozzle, and the deficiencies of rotary or centrifugal compressors as compared with the reciprocating type. The maximum temperature in a gas engine is commonly around 2,800 to 3,000 degrees, Fahrenheit, which, of course, would be utterly prohibitive without some means of rapidly conducting the heat from the affected surfaces. In a gas turbine there could be no way of cooling the blades or vanes, and these would be destroyed almost immediately. The apparent remedy is to use an expanding nozzle for converting a large part of the heat energy of the burning gases into kinetic energy, thus lowering the temperature of the gases. But this plan is defeated by the facts that expanding nozzles have not sufficiently high efficiency to enable a gas turbine to compete with a gas engine, and that even with a perfect nozzle the combustion temperature would have to be reduced to about 1,800 degrees Fahrenheit in order to get the admission temperature down to where the blades would stand it. Even if these two difficulties were solved, there remains the inherent inefficiency of the turbine runner as a converter of the kinetic energy of a rapidly moving fluid into work at the shaft, as well as the poor prospect of the rotary compressor. The turbine inefficiency is fundamental and unavoidable. In the steam turbine this is offset by the lack of initial condensation and the utilization by the turbine of the lower stages of expansion. The lack of an efficient rotary compressor, while not a determining factor, is of serious importance. A reciprocating compressor could be used, just as reciprocating pumps are used in steam turbine plants, but the size and cost of the compressor would probably make its use absurd, if not uncommercial.

There are many other difficulties to be overcome before a commercial gas turbine is produced, but these fade into insignificance in comparison with those here considered.

NOTES ON GAS PRODUCERS.

From a Paper by Samuel S. Wyer, read before the Engineers' Society of Western Pennsylvania.

The use of simple producer gas, *i. e.*, gas formed by passing air alone through a deep mass of incandescent fuel, is practically obsolete. The thermal loss by such a process is very high. To reduce this loss and also to insure a better operation of the producer, steam is admitted to the fuel bed. Many producers secure a partial destructive distillation of the coal before it goes onto the fuel bed proper. Thus the modern producer gas is made in a trinity of processes. The simple producer gas, water gas and retort gas processes are combined into one, and this is the secret of its extensive use.

The first gas producer was built in 1839 by Bischof and he was closely followed in 1840 by Ebelmen, who designed and operated three distinct types at a French iron works. These men were closely followed by Ekman in Sweden, Weding in Germany, Beaufume in France, and Siemens in England. Ebelmen understood the problem more closely than any of his contemporaries or immediate successors and anticipated several present-day types of producers. However, Siemens, in 1860, was the first to introduce the gas producer on an extensive scale.

The use of producer gas for power purposes was begun with the introduction of the Dowson producer in 1878; this, with the successful introduction of the Mond by-product process on a large scale in 1889, and Benier suction gas producer in 1895, make three epochs in the development of the gas producer.

The reactions taking place when producer gas is manufactured are not complicated. The fuel bed may usually be divided into ash, combustion, decomposition and distillation zones. However, in practice the line of demarcation between these is not very distinct.

The condition of the fire is of the utmost importance. The temperature must be kept high enough to permit the proper reactions taking place and at the same time the gas should be comparatively cool when it leaves the producer; this is especially true when the gas is to be used in engines. The advantages of "hot" and "cold" gas for furnace work have been vigorously debated in the past, both pro and con. The conclusion seems to be in favor of cool gas, if the cooling can be done in such a way as to utilize the sensible heat abstracted.

The use of preheated fuel and air and superheated steam in the gas producer is very desirable. This is especially true when the preheating and superheating may be done by heat that would otherwise be wasted. In gas power plants, the waste heat in the engine exhaust should be used in this way.

The presence of CO_2 in producer gas is always indicative of improper action in the producer. The deleterious effect of this useless constituent is greater than most people realize. In general, the percentage of fuel wasted by the formation of CO_2 will double the percentage of CO_2 in the producer gas.

The use of steam in gas producers increases the calorific power of the gas, retards clinkering, reduces the inert nitrogen and reduces the sensible heat loss in the gas by lowering its temperature. The steam acts as a carrier of heat energy. No possible use of steam can cause a gain of heat in the producer.

The methods used in introducing the air and steam into the producer are of vital importance. In pressure producers, the steam jet blower is almost universally used for this purpose. It is cheaper, simpler, and costs less than any other type. However, unless properly designed, it may be very inefficient in the use of steam and may become a source of serious loss. The solid jet blower should never be used, as it will always be wasteful. Only those types which divide the steam into thin streams and secure a thorough admixture of the air and steam should be used.

If producer gas is to be used in gas engines, it is necessary to clean it, *i.e.*, remove certain foreign constituents which would give trouble in the engine. The methods for doing this may be divided into five classes: 1. Deflectors; these depend upon the fact that the sudden deflection of a volume of gas carrying foreign matter in suspension will result in the precipitation of a part of the foreign matter. 2. Liquid scrubbers; these remove foreign matter by bringing the gas in contact with a spray, film or seal of water. 3. Coolers; the function of these is to lower the temperature of the gas and thereby precipitate the condensible constituents of the gas. 4. Absorbers or filters; these act by absorbing impurities in the gas. 5. Rotating scrubbers; these are of two types—slow and high speed; the former depends on securing a thorough admixture of the gas and some liquor, usually water; the latter, on the centrifugal force of the impurities in the gas.

The elimination of tar from producer gas is an unusually difficult problem. For this reason, where the gas is used in engines, it is now generally made from coal that yields little or no tar. Tar is a very complex mixture of a large number of chemical compounds which are very uncertain in their reactions unless the temperature of the producer is just right. If tar is brought into close contact with incandescent carbon, it will be broken up into fixed gases. Since bituminous coal, when gasified, will yield tar, the problem of gas power generation from bituminous coal is the problem of getting rid of the tar. This may be done by (1) mechanical separation; (2) washing; (3) destruction in the producer.

Gas producers may be classified as to (1) method of operation; (2) method of supporting fuel; (3) place of removing gas; (4) means of agitating fuel bed; (5) direction of blast; (6) continuity of operation, and (7) nature of draft. In general, they are divided into two classes: pressure and suction. The pressure type receives its blast from a pressure blower; in the suction type, the blast is induced by the pumping action of the gas engine piston.

The reactions taking place in the suction producer are the same as those in the pressure type. Since the rate of gasification varies with the load on the gas engine, it is of the greatest importance that the amount of steam fed to the producer should always vary directly with the load on the engine, if satisfactory results are to be obtained at varying loads. The introduction of the maximum amount of steam at half load, for instance, will soon cool the fire and cause trouble. There are now several devices on the market for securing this regulation. The vaporization of the water is done by three methods: 1. Where the vaporizer is an integral part of the producer. 2. Where the vaporizer is attached to the side of the producer. 3. Where the vaporizing device is entirely distinct from the producer and is heated by the engine exhaust.

Where producer gas is used for power purposes, the gas producer sustains the same thermal relation to the gas engine that the steam boiler does to the steam engine in a steam plant. The gas producer power plant is comparatively new in this country, but it has a brilliant future. It presents the easiest and most practical solution of the elimination of the smoke nuisance. It will also show a marked economy in labor, fuel and water consumption, stand-by and distribution losses and the handling of peak loads.

The by-product gas producer is one that abstracts certain constituents from the gas—which would otherwise be useless—and converts them into certain by-products which have a certain commercial value. The conversion of the ammonia, evolved from the nitrogen in coal, into sulphate of ammonia, is the only process that is now commercially successful. The sulphate of ammonia, being a valuable fertilizer for certain soils, finds a ready market for such purposes. The removal of the ammonia from the gas and its conversion into the sulphate requires a very extensive scrubbing system which must be directed by a skilled chemist to insure a saleable by-product. For this reason, the system is adapted only for large plants.

Producer gas has been used successfully for firing steam boilers; however, this is not generally justifiable and it would be better to use the gas directly in a gas engine and thus eliminate the boiler entirely. In plants requiring steam in the process of manufacture, the use of producer gas under the boilers would be a good practice.

The kind of fuel used for gasification will depend on the use of the gas, type of producer and the locality, the last named determining the commercial value of the raw fuel. For the plant to be successful, the three factors just mentioned must be co-ordinated in their proper relation. Practically every available fuel in this country has been used successfully for the manufacture of producer gas.

There are certain dangers in connection with the use of producer gas, on account of the extremely poisonous nature of the carbon monoxide that it contains. With common sense precautions, no trouble will result from this. However, all persons working around producer gas should be well informed as to its specific dangers and also as to the first aid to the asphyxiated.

ACETYLENE GAS STORED IN ACETONE.

From Paper read before the International Acetylene Association August, 1905, by Eugene Bournonville.

One of the successful methods for the use of acetylene gas without exposing those in the vicinity of the apparatus to the dangers of a possible explosion is by compressing the gas in acetone contained in a tank filled with a porous substance. Acetone is a liquid—an organic compound—for which acetylene gas has a great affinity. One volume of acetone at 60 degrees F. under atmospheric pressure will absorb 25 volumes of acetylene gas; under 12 atmospheres, 300 volumes. Thus the solubility increases in proportion to the pressure at the rate of 25 volumes for each and every atmospheric pressure. It has been determined that acetylene stored in acetone at 150 pounds pressure is safe! But to further guard against explosion the tank in which the acetone and gas are stored is filled with a porous substance which acts as a factor of safety. It has the practical result of holding the gas or liquid under a high state of compression in minute quantities between the fibers of the material which may thus be regarded as stored in vessels whose diameters are less than that in which an explosion can be propagated.

By this method an enormous quantity of acetylene gas can be stored, and transported safely under comparatively low pressure in cylinders of moderate size; and when the pressure is relieved the acetylene gas escapes gradually. The acetone can be used over and over again for the storage of actylene gas, the loss in acetone being only about 1 pound per 1,000 cubic feet of acetylene.

This method of storing acetylene gas is controlled by the Commercial Acetylene Co. in this country and Canada. The porous substance used by them is a very fine fiber of asbestos bound together with silicate of soda and melted in cakes to exactly fill the interior of the cylinder for which they are intended. The porous material must not have more than 80 per cent of porosity. The method of storing acetylene gas in porous material saturated with acetone is as follows:

First. Reservoirs or cylinders made of soft steel are employed and are guaranteed by the makers to withstand 1,200 pounds pressure to the square inch. These cylinders are made by the Air Tight Steel Tank Company, of Pittsburg.

Second. These cylinders are filled completely with sections of porous asbestos, molded to fit and fill completely the inside of the cylinders. The asbestos is inserted into the cylinder by the makers of the cylinders, before the bottom is brazed on to it.

Third. When the cylinder is received at the charging plant of the Commercial Acetylene Company, a high pressure valve is inserted in the head of the cylinder, then the cylinder is connected to a vacuum pump, to exhaust all the air contained in the cylinder.

Fourth. When all the air is exhausted from the cylinder a pipe is attached to the stud valve of the cylinder, and the other end of the pipe is immersed into a quantity of acetone, representing 43 per cent of the entire volume of the inside measurement of the cylinder; then the stud valve is opened and all the acetone is drawn into the cylinder by the suction from the vacuum previously made, and the minute the last drop of acetone has entered the pipe the stud valve is closed tight.

Fifth. When the proper quantity of acetone is in the cylinder, the cylinder is connected to the acetylene gas compressor, and the gas is forced into it until the pressure gage registers 2 atmospheres, or 30 pounds pressure, then the stud valve is closed tight and the cylinder is left in that condition for 24 hours, after which time the stud valve is opened and all the acetylene in excess of the 25 volumes absorbed by the acetone at atmospheric pressure is allowed to escape in the open air. This is done as an extra precaution, in case that all the air would not have been exhausted by the vacuum pump. As the acetone absorbs gas only and does not absorb air when the stud valve is open, the air is the first to come out, being chased by the acetylene, emerging from the acetone.

Sixth. When the gas stops flowing out, the cylinder is ready to be charged definitely, and then to be put into service, which is done by connecting the cylinders to the compressor, and charging to 10 atmospheres pressure.

Data Relative to a Railroad Cylinder of 21 Cubic Feet Capacity.

(All the data following are at 62 degrees F.)

	Cubic Feet.
Inside cubic measurement	21
Asbestos (space occupied by) 20 per cent	4.20
Acetone (space occupied by) 43 per cent	9.03
Space left in porosity when not charged with acetylene gas	7.77
Volume of acetylene gas taken to saturate the acetone	225.75
Volume of acetylene gas absorbed by acetone at 150 pounds pressure after the acetone has been saturated with same	2,257.5
Volume of acetylene gas stored in the empty space left in cylinder	45.40
Total volume of acetylene gas available	2,302.9
Weight of acetylene gas contained in cylinder when charged at 150 pounds pressure	165.62 pounds

Space occupied by absorbed gas	3.23
Space left free in cylinder when charged at 150 pounds pressure, 62 degrees F	4.54
Space occupied by absorbed gas, acetone and asbestos, combined	16.46

THE USE OF OXYGEN IN REMOVING BLAST FURNACE OBSTRUCTIONS.

Abstract of Paper by Chevalier C. de Schwarz read before the May (1906) Meeting of the Iron and Steel Institute.

All experienced blast furnace engineers are acquainted with the great trouble caused by the taphole of blast furnaces becoming closed up with solid iron so that it cannot be opened by ordinary appliances without considerable loss of time. The usual means employed for opening a closed taphole is a steel bar driven by hand rammers, or if these do not suffice, a heavy ram suspended on chains and worked by a dozen men is employed. It sometimes happens that the steel bar snaps off, leaving the broken end in the hole already made, and making matters worse than they were before. Coke and heated blast as well as petroleum have been employed for opening closed tapholes or tuyeres and also a strong electric current but none of these work quickly enough and are besides very expensive. The application of compressed oxygen has worked very quickly and has, besides, the merit of being cheap. The iron to be pierced is first heated at the spot selected for making the hole by means of an oxy-hydrogen flame. The oxygen and hydrogen gases are compressed in two separate steel flasks, each flask being provided with suitable outlet valve. The burner consists of an outer and inner tube, the outer tube supplying the hydrogen and the inner tube the oxygen. The hydrogen is turned on first after which the stream of oxygen is turned on. The pressure of both gases is first kept low, but is gradually raised and regulated in such a way as to give a very hot flame which heats the spot upon which it impinges to a white heat. The pressure of the oxygen is then raised to such an extent that the iron commences to burn, which is shown by sparks being thrown out. Thereupon the pressure of the oxygen is increased to about 450 pounds per square inch while the supply of hydrogen is entirely shut off. It is now that the iron burns, thus replacing the hydrogen as a combustible, whereupon a degree of heat is developed which far surpasses that produced by the oxy-hydrogen flame. The high pressure of the escaping oxygen at the same time served to force out all the molten iron, thus keeping the hole burned through perfectly clean throughout the operation. This explains why it is possible to perforate a solid block of cold iron or steel say 16 inches thick. Moreover, this extraordinary feat can be performed in one or two minutes, it is claimed.

The explanation of the great increase of heat due to the use of pure oxygen will not be without interest. Burning 1 pound of hydrogen with oxygen produces 62,000 B. T. U., while burning iron with oxygen produces 2,968 B. T. U. but at atmospheric pressure 1 pound of hydrogen occupies over 80,000 times as much space as 1 pound of iron. Therefore a certain volume of iron when burning with oxygen produces about 4,000 times as much heat as an equal volume of hydrogen in the same space. In other words, when iron burns in oxygen the heat evolved is concentrated on a very small area. This explains the enormously high temperature produced and the quick action, notwithstanding that at the same time the temperature of the compressed oxygen is low because of its compression and subsequent expansion. This is indicated by the fact that the tube leading to the oxygen flask to the burner often becomes coated with ice, the temperature of the tube often being only about 14 degrees F.

So intensely local is the heating effect that the flame may be directed so as to clean out a thin slag tuyere hole 1⅜ inch diameter without injuring it in any way. Moreover it may be used for piercing armor plate for battleships. A hole through such a plate say 9 inches thickness would require two or three hours if drilled in the ordinary way, while with the compressed oxygen flame it may be perforated within 15 or 20 seconds! In rolling mills where an interruption of the work is very costly the oxygen process may often be advantageously used in melting through and quickly removing broken couplings, flywheel hubs and other parts which require much hand labor when done by means of chisels and drills. So certainly can the action of the oxygen flame be controlled that it has been used for cutting off boiler tubes and for cutting boiler plates to any required shape. It is said that the apparatus for guiding the tubes works in such an easy and exact manner that the slightest pressure of the hand suffices to guide it exactly as desired. The cost of oxygen gas is quoted as being about 75 cents per thousand cubic feet. For opening up a blocked taphole or a tuyere as a rule not more than 8 or 10 cubic feet of oxygen are required and in exceptional cases sometimes 20 to 40 cubic feet are used, hence in the extreme cases the use of the new process is not at all expensive. Moreover the apparatus is very simple and easy to maintain. Inasmuch as the hydrogen is only used to start the process it follows that any other means of raising the initial temperature to the required degree will allow the oxygen process to be used, hence preliminary electrical heating can be used instead of the oxy-hydrogen flame, and this has been done.

A NEW METHOD OF PUMPING HEAVY CRUDE FUEL OIL OR OTHER THICK VISCOUS FLUID.

John D. Isaacs, in *Engineering News*, June 7, 1906.

The crude oil product of most of the California fields is a very heavy, thick and viscous fluid with an asphalt base. The entire product of the Kern River fields, near Bakersfield, is particularly heavy, its density averaging about 14 degrees Baume. Up to the present time, this oil has been transported from the fields in cars. Although attempts have been made to facilitate its movement by long pipe lines, these trials have met with little success, as it was found necessary to use very high pumping pressures, necessitating expensive pipe and powerful pumping plants placed so close together that operating expenses became too high for practical economy, and moreover with such a plant the delivery was very small.

Various attempts were made to overcome these difficulties, the most important being the heating of the oil. This was a decided help in short pipe lines, but a temperature sufficient to be effective for long distance pumping caused the disintegration of the oil and the deposit of asphaltine, called by the oil men "carbonizing," thus clogging the line. Water was also introduced with the oil, but 30 per cent of water was needed to materially improve the results and the surging of the mixture through the line soon caused an emulsion of the oil and water, which is very difficult and expensive to separate, necessitating heating the oil to 180 degrees F. The mixing of the lighter oils with the heavy oils has made it possible to pump the mixture, but in the fields where only the heavy oils are obtained, this necessitates the pumping of the light oils to such fields from long distances, and as the mixing of the oils causes a loss in the value of the light oils, which have a market value much higher than the heavy fuel oils, the process is very expensive.

A new process has been adopted by the Southern Pacific Company which has led to the construction of a "rifled pipe line." The method is to rifle the pipe, giving it an interior appearance similar to that of a rifle barrel, while a small percentage of water is pumped with the oil. The rifling of the pipe causes the entire liquid mass to whirl, and as the water is heavier than the oil it is thrown to the exterior of the mass, thus causing the envelopment of the oil with a thin shell or film of water. This forms a water lubrication between the oil and the pipe, greatly reducing the friction and allowing the plug or core of oil to glide through the pipe readily.

When this principle was discovered the first experiment was made with a small lead pipe. In the process of drawing ordinary lead pipe the interior surface is slightly scored in close longitudinal lines. The pipe was first used as received and friction co-efficients determined; it was then twisted by hand, causing these longitudinal scorings to become helical, which was sufficient to cause a rotation of the oil and water when passed through the pipe. Experiments made with this

rifled lead pipe indicated the soundness of the principle and led to an experiment on a larger and more practical scale. One-half mile of 3-inch standard line pipe was used in the next experiment, which was performed by the Southern Pacific Company at West Oakland. The pipe was first rifled by the insertion of helical wires. This was accomplished by simply drawing tempered steel wire from a coil through the pipe in lengths of 500 feet at one time, the spring of the wire causing it to cling closely to the sides of the pipe, forming a helix. This pipe was then laid and subjected to an exhaustive experimental operation with heavy Kern oil. The best results were obtained by pumping about 10 per cent. water with the oil. A flow was obtained many times that obtained by pumping pure oil, or oil and water, through an ordinary plain pipe. The 3-inch line was then rifled, by passing the pipe through a series of rollers, to a pitch of 1:5 with the line of the pipe. Experiments on these lines gave even better results and lower co-efficients than those from the lead pipe and justified the construction of a practical rifled pipe line for transporting oil commercially.

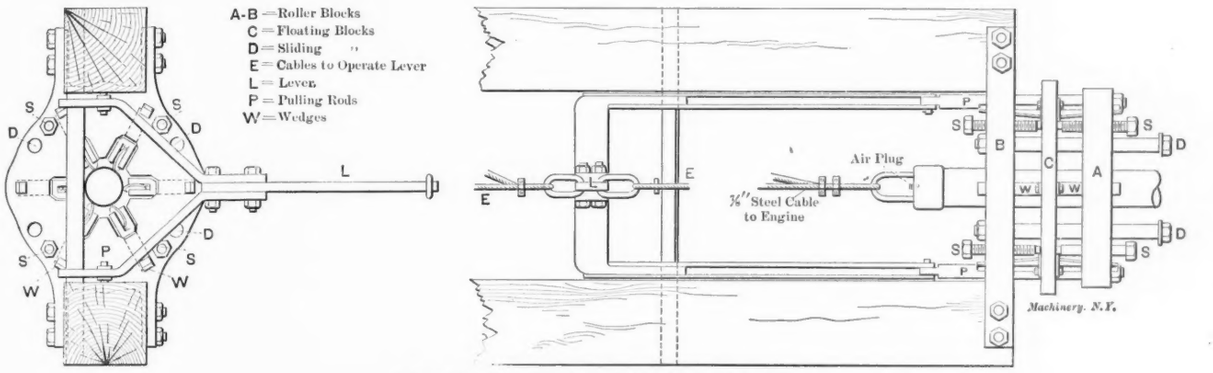
A rifled pipe line was finally constructed 31.17 miles long, between Volcan, a point located centrally in the oil fields and on the Southern Pacific Company's railroad, and Delano, another station northward on the same railroad at an elevation of 120 feet below Volcan. The pipe used was standard 8-inch line pipe, weighing 28.2 pounds per foot, fitted with recessed line couplings and tested to 1,200 pounds per square inch. The pipe was laid in a ditch to a depth of about 2 feet and screwed together by four pairs of 8-inch lay tongs handled by sixteen men. The ditch was dug about 18 inches wide and the pipe laid zigzag within the easy elastic bending of the pipe to provide for expansion by heat. In the vertical plane, the pipe was also laid with a vertical zigzag or wave of about 400 feet in length or shorter, the depth of these waves being about the diameter of the pipe, so as to form traps at 400 feet intervals. The object of these traps is to accumulate water at frequent intervals when the line is shut down, thus preventing the formation of a long plug of solid oil, and facilitating the restarting of the line.

The line was first tested with water and all breaks and leaks repaired until the entire line held 1,000 pounds pressure. The line was next subjected to a continuous operating test, lasting 24 days. During this run an average of over 14 barrels, net oil, in 24 hours, was obtained for the entire run at an initial pressure of 800 pounds per square inch. For several hours at various parts of the test over 675 barrels of net oil per hour was pumped at 800 pounds. The oil furnished was exceptionally heavy and had stood for a long period in an earthen storage reservoir so that much of its light constituents had evaporated. The temperature of the oil was below 60 deg. F. when received at Delano, and in no case was over 75 degrees F. when received at the pumping station, averaging much lower. Experiments show that the maximum flow of oil was obtained when about 10 per cent of water was used. At the end of the line, the water and oil were found entirely separate and when run into the settling tanks the water was easily tapped off, leaving only about 1 per cent in the oil shipped. From Delano the oil was shipped away in cars for commercial use.

The pumping station consists of three 200-horsepower boilers of the return tubular type fitted with water heater, duplicate feed pumps and pressure burners. The main pump is a compound duplex steam pump, 25 and 42 inch steam cylinders with 9½-inch oil plungers with 36-inch stroke. The auxiliary water pump is a duplex plunger steam pump, 16-inch steam cylinders, 5-inch plungers and 12-inch stroke. The oil supply tank is placed 30 feet above the oil pump and a 27-inch suction pipe about 100 feet long is used, thereby insuring an ample supply for this pump. The water is injected by means of a special injection nozzle. A piece of 7-inch well casing is introduced inside the 8-inch pipe; oil passes through the inner pipe and water is introduced through the annular space between the two pipes, both thus starting off in their proper relative position. A short baffle, or twisted plate, is placed in the inner tube at this point to give the oil an initial whirl.

The pipe was "rifled" in the following manner by the machine shown in the accompanying sketch: The large disks *A* and *B* carry six rollers, each mounted in roller fork bearings. The central disk *C* is a floating disk, to which are attached wedges *W*, these wedges tapering outward on both sides of the disk, one wedge being opposite each roller fork, and engaging therewith. When the disks *A*, *B* and *C* are apart, the rollers are open wide enough to allow a pipe coupling to pass freely between them. By means of the pulling rods *P* operated by the lever *L* the three disks are drawn together to any limit set by the adjustable stud bolts. This drawing together of the three disks causes the wedges to thrust the roller forks toward a common center, that is, indent them into the pipe to any desired depth. The rollers were set to a pitch of about 1:5 with the line of the pipe. The disks are so spaced that each roller in disk *A* lines up with the one just to the right in disk *B*, so that when the pipe is drawn through it rotates one-sixth turn between the two disks. Thus, for one turn of the rifling in 10 feet of pipe, the disks would be one-sixth of 10 feet apart in the closed position, or 20 inches. The circumference of an 8-inch pipe is about 25 inches, so that the pitch of rollers to correspond to one turn of rifling in 10 feet would be as 25:120. The male thread of each length of pipe was fitted with a pulling plug, having an air vent, and a testing plug on the coupling end by which water was introduced. The pipe was filled with water, the pressure raised to 1,200 pounds, and then released. If the pipe stood the test satisfactorily, it was placed in the rifling machine, the rollers being closed just behind the pulling plug so as to indent the pipe to a depth of 3/32 inch. By means of a hoisting engine and a pair of triple blocks, reeved with a ⅞-inch steel cable, the pipe was drawn through the machine, the rollers describing six helical paths around the pipe, one complete turn in each 10 feet. The result was a pipe spirally indented and having the appearance of being rifled when looked into at one end. The rollers were then opened, the pipe drawn out, and subjected to 1,200 pounds water test. During the operation of the machine, the rollers were flooded with lubricating oil.

The results show that the rifled process increases the flow of net oil through a long pipe line eight to ten times that of the plain pipe under similar conditions as to diameter of pipe, pressure, etc.



Rifling Machine for putting Spiral Grooves in Pipe.

ESTIMATING WEIGHTS OF FILLETS AND ROUND CORNERS.

In estimating the weight of a casting it is not usual to make any allowance for fillets and round corners. They generally are so small as to not make much difference in the final result and are quite likely to balance each other as well. That is to say, the weight that would have to be added if the fillet were taken into account will ordinarily just about balance that which would have to be subtracted if the rounding of the corners is considered. In castings, however, where rounds of large radii are used either for corners or edges it often becomes necessary to take them into account. To assist in doing this in the simplest manner the following method of procedure may be helpful.

Take the case of the casting shown in Fig. 2. This does not look like any piece that was ever made for a practical purpose, but it will serve us well enough in illustrating the principle involved. First consider the piece as being composed of two cylindrical portions, one of them 3 inches in diameter by 2¼ inches long, the other ⅞ inch in diameter by 1 inch long. To make a truly cylindrical body of this piece it will be necessary to add to it a piece like that shown in section in Fig. 1 to change the round corner to a square one, and we will also have to remove a piece like that shown in section in Fig. 3, an operation equivalent to removing the fillet. In the same way to get the weight of the body we may first obtain the weights of the two cylindrical portions whose dimensions were given above, and subtract from the sum of these weights that of Fig. 2 and add to it that shown in Fig. 3.

The volumes, and from these the weights, of these two imaginary bodies may easily be obtained by considering them as being "solids of revolution." This term means that Fig. 1, for instance, is generated by the area *A B C* rotating about the center line of the figure. The volume of such a solid is equal to the area of the figure *A B C* multiplied by the circumference of the circle made by the center of gravity of *A B C* in its revolution. If the center of gravity lies in line *y y* it will be a distance *R*, from the center and the length of the circumference of the circle which it makes will be equal

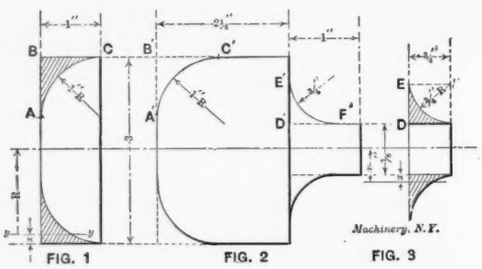


FIG. 1 FIG. 2 FIG. 3

to 2 π *R*. The volume and the weight of the solid in Fig. 1 are thus equal to that of a body of similar material having a similar cross section, *A B C*, and a length at right angles to the section of 2 π *R*. The same may be said of the solid in Fig. 3, which will be equal to a body having cross section *E D F*, and a length perpendicular to this section equal to 2 π *r*.

The area *A B C*, left after subtracting from a square with a 1-inch side, a quadrant with a 1-inch radius, has its center of gravity located at a distance of about 0.22 inch from either of the straight sides of the figure. For any similar figure this dimension, *x*, will be equal to 0.22 × the radius. This gives us a simple means of finding the dimension *R*. In Fig. 1, *X* is equal to 0.22 × 1 = 0.22. *R* evidently equals 1.5 — 0.22 = 1.28. The circumference of the circle made by the center of gravity of the section is then equal to 2 × 1.28 × π = 8.0425 inches. This multiplied by the area of section will give us the volume of the figure. The area may be found by subtracting from the area of a 1-inch square ¼ of the area of a circle having a 1-inch radius. The following table (see data sheet in supplement) has been prepared, giving the areas of these sections for radii from 1/16 inch up to 5 inches. Other columns are also given in which are computed the weight per foot and the weight per inch of these sections of fillets for steel, cast iron and cast brass. Using this table we find that the weight of the body if made of cast iron will be equal to 0.0559 × 0.0425 = 8.4495 pounds.

To find the weight of Fig. 3 we proceed in a similar manner. *r* = 0.4375 + (0.22 × ¾) = 0.6025. The circumference of the circle traced by the center of gravity of the section will then equal 2 × π × 0.6025 = 3.7856. From the table in the supplement, the weight per inch for a cast iron fillet section having a ¾-inch radius is equal to 0.0315 pounds. The weight of the figure is then equal to 3.7856 × 0.0315 = 0.1192.

To find the total weight of the body in Fig. 2 use may be made of the following tables, see data sheet supplement, for

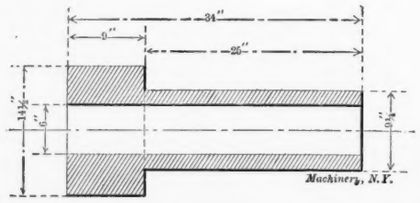


Fig. 4.

solid cast iron cylinders. These tables give the weight per inch for such figures. A 3-inch cylinder 1 inch long is found to weigh 1.98 pound. A cylinder 3 inches in diameter 2¼ inches long will, therefore, weigh 1.98 × 2¼ = 4.455 pounds. In a similar way the smaller cylinder, which is ⅞ inches in diameter by 1 inch long is found to weigh 0.1684 pound. As explained in the first paragraph, to obtain the weight of the body in Fig. 2 we must add the weight of the two cylinders to that of the solid in Fig. 3 and subtract from it that of the solid of Fig. 1. Performing these operations we have 4.623 + 0.119 — 0.449 = 4.293 pounds or the desired result.

A further example may be given to show the use of the table of weights of solid cast iron cylinders when it is desired to compute the weight of hollow cylindrical bodies. Let us estimate the number of pounds in the casting shown in Fig. 4. To do this find the weight of a cylinder 14½ inches in diameter by 9 inches long, add to it the weight of a cylinder 9¼ inches in diameter by 25 inches long and subtract from the total the weight of a cylinder 6 inches in diameter and 34 inches long. The example is performed below:

$$\begin{aligned} 46.23 \times 9 &= 416.07 \\ 18.81 \times 25 &= 470.25 \\ \hline & 886.32 \\ 7.92 \times 34 &= 269.28 \\ \hline & 617.04 = \text{Ans.} \end{aligned}$$

This table has been used by its compiler for a number of years and he vouches for its accuracy. Allowance is made in it for shrinkage, swelling of cores, etc., so that it is perhaps more strictly accurate as applied to rough castings than to finished ones.

* * *

The brazing of gray cast iron is made difficult because of the presence of free carbon or graphite, in the iron. To braze cast iron successfully it is first necessary to decarbonize it in the vicinity of the joint, and then the action of the spelter is the same as with wrought iron or steel. This is the principle on which most, if not all, of the various cast iron brazing compounds on the market are used. The usual decarbonizing agent is sub-oxide of copper, which when heated in conjunction with cast iron oxidizes the carbon and deposits free copper in the iron, thus not only decarbonizing the iron but giving it a preliminary coat of copper which readily takes the spelter. The spelter is then applied with a suitable flux and treated in exactly the same manner as with ordinary brazing.

* * *

The idea of making the bottom steps of a long staircase of progressively greater height as they approach the bottom has recently been patented. The scheme is supposed to prevent congestion at the bottom of the stairway, as people will descend faster at the lower end of the staircase than at the upper. This idea is ingenious, but it has the fault of making the steps of uneven height and this tends to cause stumbling.

EXPERIENCES WITH AN ALLIS-CHALMERS TURBINE.

The first large steam turbine to be built and started up in this country by the Allis-Chalmers Co. was one of 5,500 K.W. rated capacity, installed at the Kent Avenue power house of the Brooklyn Rapid Transit Co. The contrast between the time required to place in successful operation a turbine unit of this size and a vertical reciprocating engine of corresponding power is illustrated in a striking manner by the record made in placing this turbine in running condition. The turbine

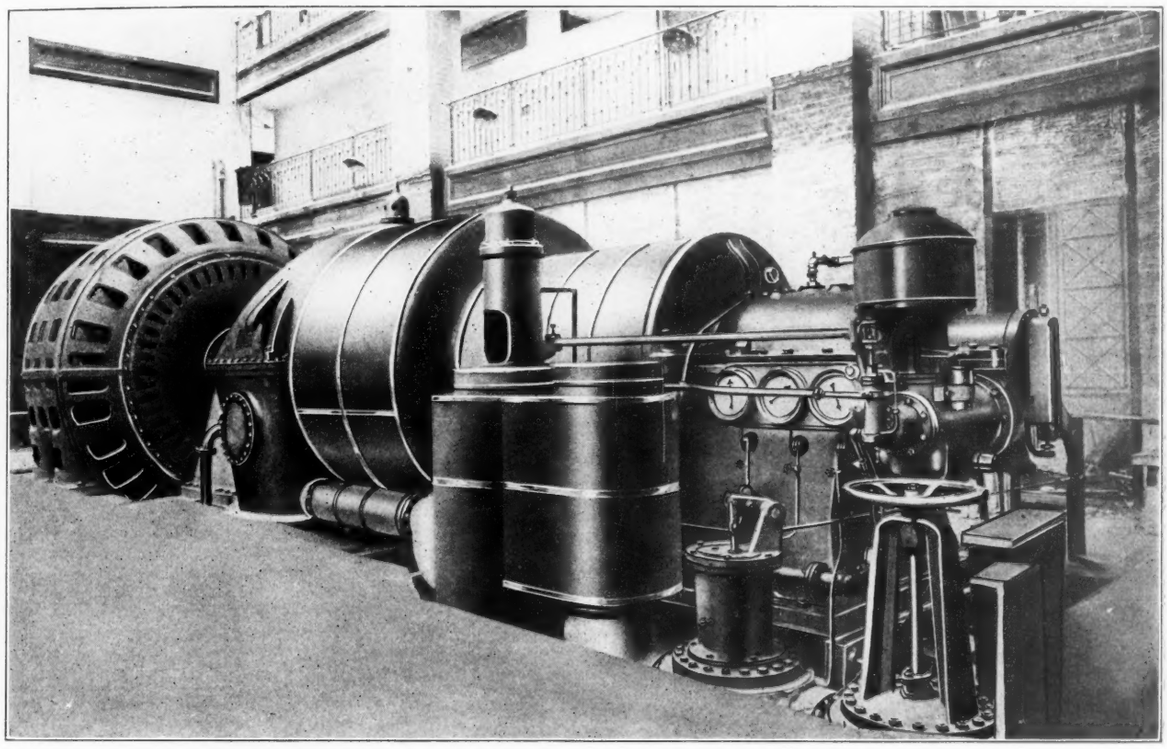


Fig. 1. Allis-Chalmers Turbine of 5,500 K.W. Capacity, at Kent Avenue Power House, Brooklyn, N. Y.

and its direct-connected generator were ready for operation on February 1, but the boilers and auxiliary apparatus were not completed until late in March. While left idle for several months the insulation of the generator windings naturally became damp, and therefore, as soon as steam was available, the turbine was started up at part speed to dry out the generator. While this drying-out process was in progress a mishap at another power house left the railway company short of power and an urgent request was made of the Allis-Chalmer Co.'s representative to place the new turbine under load. Additional boilers were therefore fired up and tests were made of the insulation, indicating that the generator was safe for the rated voltage of 6,600. The turbine was then started and run at the full speed of 750 revolutions per minute for the first time since the installation, and an hour later an increasing load was put on until the machine was delivering 3,000 K.W., which was all the railway company needed. Two hours later more load was called for and the turbine was allowed to deliver 4,000 K.W. On the following day the load ran up to over 5,000 K.W. and on the succeeding day it reached 7,000 K.W.

Three days later an opportunity was afforded for opening the turbine casing for examination and here an agreeable surprise awaited the engineers. Heretofore in the operation of turbines there has been more or less trouble from the casing arching upward under the effect of superheated steam on account of the top of the cylinder expanding more than the bottom, this being due to the fact that the casing has not been made entirely symmetrical, sometimes having ribs or heavier parts on the bottom than on the top part. In a considerable number of instances this has caused the blades to come in contact with the cylinder and be ripped out. In the design of this turbine it was sought to overcome the distortion of the cylinder by a more equal distribution of the metal and at the same time the turbine drum was placed slightly above the center of the cylinder to assist in preventing contact of the blades in case of distortion. When the turbine was opened up, however, it was found that the compensation for distortion had been slightly overdone and that the casing had sagged a small amount, and this, together with the high position of the drum, had caused the blading to rub hard for nearly a third of the length of the turbine. The drum was therefore lowered a few thousandths of an inch at each end, which has prevented further rubbing. In the January, 1906, issue of MACHINERY the details of construction of the Allis-Chalmers turbine were shown. The leading characteristic is the system of blading, whereby the blades are built up into rings which are afterwards inserted in grooves in the rotor and stator of the turbine. The outer ends of the blades are supported by a channel-shaped shroud to which the blades

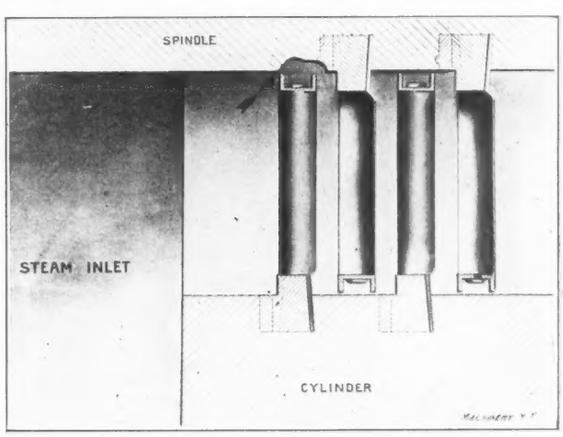


Fig. 2. Sketch to Illustrate Severe Treatment Received by Turbine without Damage to Blading

are riveted, which makes a stronger and safer construction than where the outer ends of the blades are both unsupported and unprotected. One trouble with the Parsons type of turbine has been that in case of the blades rubbing or of any foreign substance getting into the turbine, some of the blades would be ripped out, since in case the interference came at

the outer ends of the blades there would be sufficient leverage to break the blades at the points where they are unsupported. In the case cited above, the blades were wholly uninjured and no damage whatever was done to the turbine.

A still more interesting incident was discovered after the turbine had been in continuous operation for nearly a month. It was found that a large jack-knife had been left inside the turbine which had been running with a knife blade wedged in between the rotor and stator and the latter part of the time with the shrouding of the blades grinding against the stator; yet when opened up it was found that no destruction of the parts had occurred and there was no damage done to the blading. The possibility of some foreign substance or an object like a knife or a monkey wrench being accidentally left inside the turbine casing has not, of course, been taken into consideration in steam turbine design; but the fact that this machine was not damaged by such an obstruction indicates that the method adopted for blading has overcome the difficulties arising from contact between the stationary and moving elements from whatever cause this condition arises.

At the time of the discovery of the knife the turbine was opened because a peculiar noise was heard in the turbine cylinder when starting up on that morning. A piece of steel had gotten between the spindle and the shroud of the first row of stationary blades, and acting like a lathe tool, had cut into the body of the drum for a width of about three-eighths and for a depth of nearly three-sixteenths of an inch, this cut being inside of and opening into the groove which holds the first row of spindle blades in Fig. 2. This had loosened the calking strip which held the ring of blades in place. For a distance of 5 or 6 inches this strip had come partly out of its groove, thereby loosening the ring of blades. This latter under the influence of centrifugal force had bent outward so that the channel-shaped shroud ring had rubbed hard in the bore of the cylinder, and the flanges of the ring had been worn down almost to the heads of the rivets which hold the ring to the blades. Not a single blade, however, had come out or even become loosened or injured in any way.

Fig. 3. Large Jack-knife Accidentally left Inside of Turbine Casing, where it Received Harsh Treatment.

Not wishing to keep the turbine out of service long enough to make permanent repairs, the erecting engineer removed this one ring of blades, closed the cylinder and immediately put the turbine back into service. Fig. 3 shows the knife after it had been subjected to the grinding within the turbine, which shows the harsh treatment it received and indicates the rough usage, also, to which the turbine must also have been subjected.

THE GLEASON GENERATING BEVEL GEAR PLANER.

Many of our readers, of course, are familiar with the gear planer of the template type built by the Gleason Works, Rochester, N. Y., in which formers of the required tooth shape guide a planing tooth in cutting the teeth of bevel gears. These formers represent a section of a tooth of a bevel gear of the required cone angle taken at a point say two or three times as far removed from the apex of the gear as is the middle section of the teeth of the gears planed; consequently slight local errors of shape of the formers are reduced in the copying process.

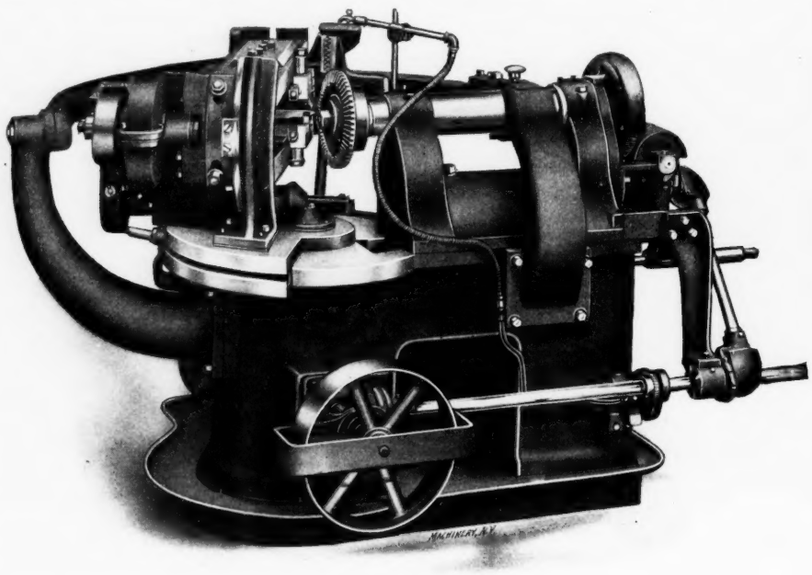


Fig. 1. New Generating Bevel Gear Planer made by the Gleason Works, Rochester, N. Y.

These machines do excellent work and are well adapted for cutting gears of the coarser pitches. They are not, however, so accurate or rapid for cutting large quantities of gears of the finer pitches as a new type of bevel gear planer recently developed by the Gleason Co. in which the shape of the tooth outline is generated without the use of any formers whatsoever. In this machine two cutting tools are in operation simultaneously and the action is entirely independent of formed surfaces, save those of the simplest types, *i.e.*, cylindrical and plane. The two tools working on a tooth at once double the speed of cutting, balance the thrust of the cut and minimize vibration. This construction also cleverly avoids the inter-

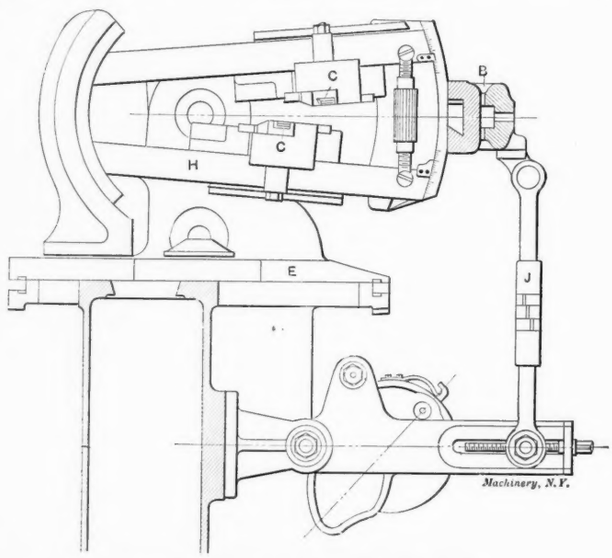


Fig. 2. Showing Slides Carrying Cutting Tools.

ference of the tools likely to occur near the apex of long face gears if working in the same direction coincidently.

The general appearance of the machine is shown in Figs. 1 and 3 which are views taken from opposite sides; Fig. 4 is a line cut showing a plan view of the machine with a bevel

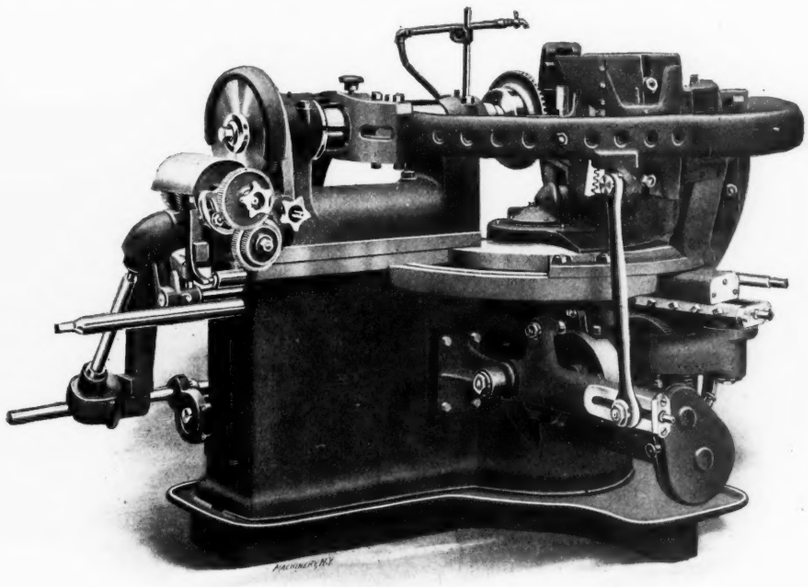


Fig. 3. Rear View of Gleason Gear Planer.

gear blank *A* in position on the work spindle *F*. The two cutting tools referred to in the foregoing, one of which is at *C*, represent adjacent teeth of a crown gear, their lines of cutting action, of course, being radial to the sphere. The sides of the tools are straight and as they form the bevel teeth by the molding planing process it follows that the shape of the tooth is of the so-called "octoid" form identical with that produced by the Bilgram bevel gear planer. As the bevel gear blank rolls in the Gleason machine, the slide carrying the cutting tool moves coincidently with it but in a vertical plane, the movement being analogous to that of a rack meshing with a spur gear, although radial and its center of motion corresponding, of course, to the center of the imaginary crown-wheel. During this period of engagement of the imaginary crown-wheel with the bevel gear blank the cutting tools reciprocate and plane both sides of the tooth to the correct theoretical shape throughout its length. Preferably the blanks are first roughed out on another machine so that about all that the generating machine has to do is to take off a "skin" cut. This practice is considered best for, while the generator is well adapted to cutting teeth from the solid, time is saved by adopting the roughing process on another machine and doing the finishing process on the generator. The tools will last from 12 to 36 hours when used for finishing alone, and this is an important consideration. The function of the generator is really that of a precision machine which puts on the finishing touch of what is a delicate operation; that is, forming an accurate gear tooth contour.

The slides carrying the cutting tools are relatively adjustable, as will be seen by referring to Fig. 2, the feature of adjustability being necessary to adapt them to various tooth angles. The circular turntable or turret, *E*, on which they are mounted is also adjustable in a horizontal plane for cone angles and an independent automatic action of the turret is given in this plane which will be explained later. Motion for the reciprocating tool slides is conveyed up through the center of the turret but the oscillating motion of the slides in a vertical plane is communicated through a semi-circular swinging arm, *B*, by the toothed connection shown in Fig. 4; this arm is keyed to the work spindle, *F*. The working connection to the tool slide arm, *H*, is made through a crown-wheel segment attached to *H*, and a change bevel segment, *D*, mounted on the oscillating arm. The cycle of operations in planing a tooth already roughed out is substantially as follows:

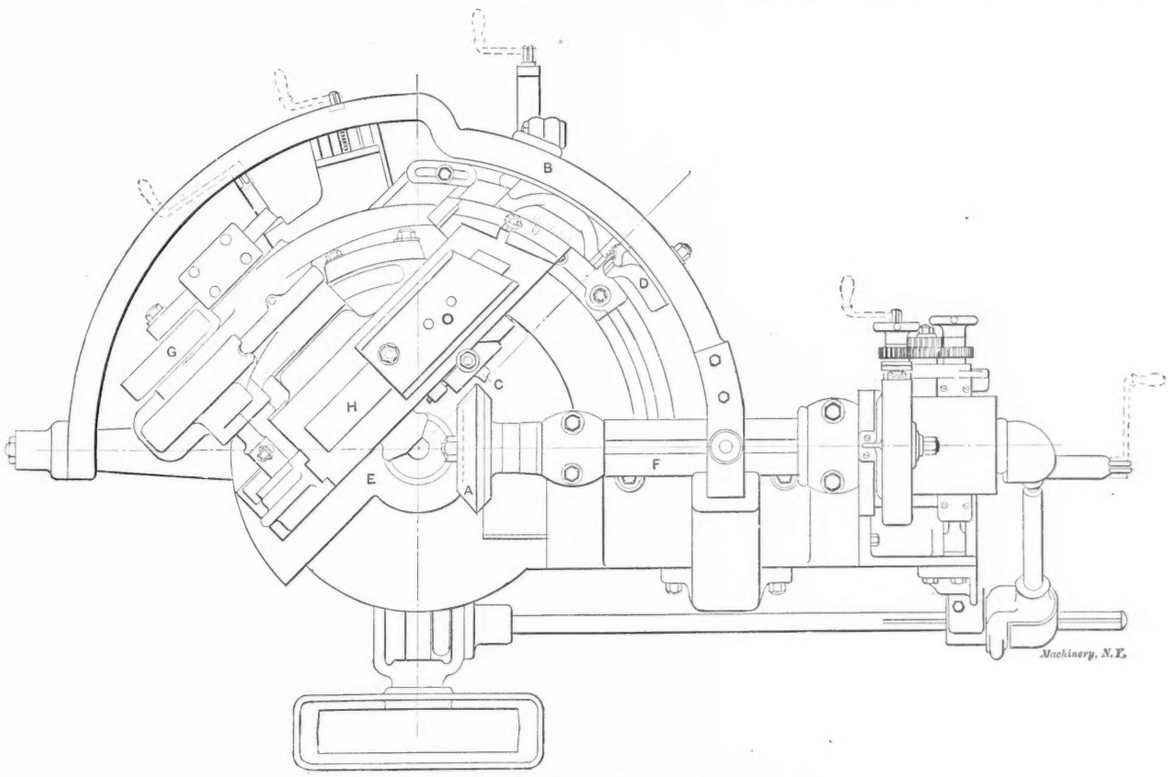


Fig. 4. Plan View of Gear Planer.

The generating process of the tooth begins with the oscillating slide in the middle position. The slide arm moves downward to its lowest position and the gear blank rolls with it at the same rate, measured on the pitch lines, the cutting tools meanwhile reciprocating and planing each side of the tooth to shape. Having reached the lowest point of engagement the action reverses and the slides and blank roll together to the highest point of engagement, again reverse and return to the center; thus, the tools pass over the same surface twice. With the slides in this central position the turret automatically moves the tools out of the plane of the tooth just formed and the gear is indexed one space, whereupon the tools are returned to the cutting position and the cycle of operations is repeated and so on automatically until the gear is completed.

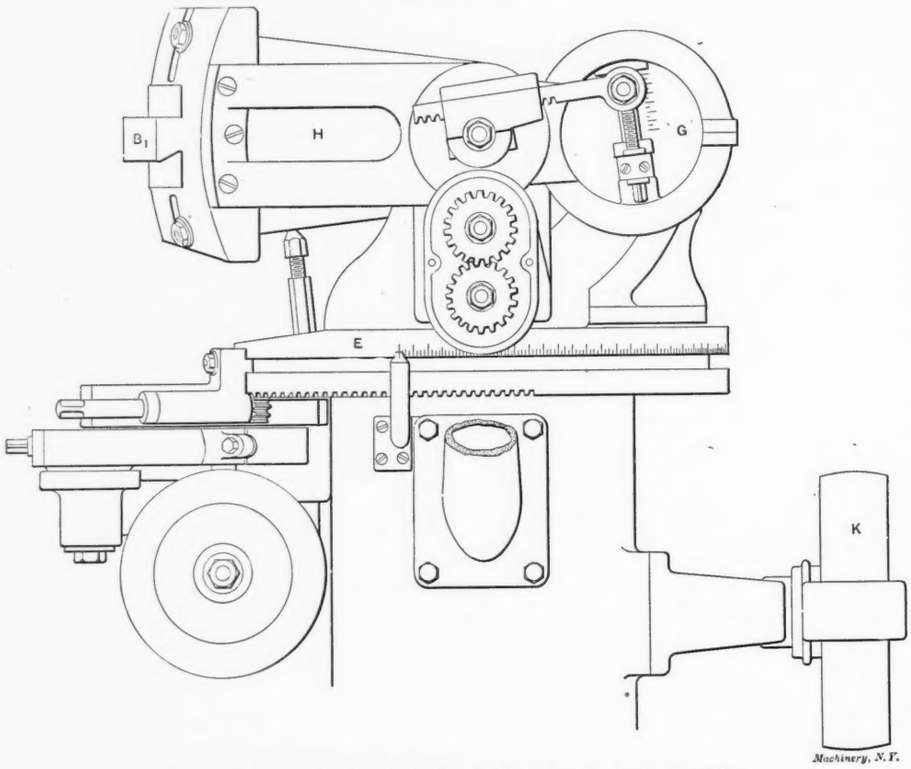


Fig. 5. Elevation showing Mechanism for Operating Reciprocating Slides.

Perhaps the most difficult feature of design of the generating gear planer of this type was the provision of mechanism which would move the cutting slide representing the crown wheel and the gear at the same velocity ratio. It will be understood that the pitch line of the crown gear represented by the cutter slide is unchanging in its pitch diameter, whereas the diameter of the pitch line of the bevel being planed changes with the cosine of the angle made by the axis with the side of the cone. The first design of the Gleason generating machine brought out had a compensating device connecting the oscillating arm with the spindle which gave an approximate agreement of velocity ratio for all angles of bevel gears likely to be met with in ordinary practice, but inasmuch as it was not theoretically correct it was subject to some criticism. In this machine a bevel segment, *D* (of which nine are provided) corresponds to the angle of the gear being cut, either exactly or approximately and gives the direct and accurate coincident movement of the blank and cutter slides for all bevels within the machine's capacity.

* * *

WATERPROOF CEMENT.

A German patent has been granted for a cement of which the inventor claims a one-half inch thickness will make any brick wall absolutely waterproof. To each 200 pounds of Portland cement clinker is added a mixture of ¾ pound of Japan vegetable or berry wax, and 1 ounce of caustic lime which has been dissolved in 14 pints of boiling water. These ingredients are thoroughly mixed and when cooled are dried and all are ground together very fine.

THE OLD MAN GETS A JOKE ON US.

A. P. PRESS.

You remember a month or so ago I wrote you of a joke we got on the "Old Man"; well, the boot is on the other foot this time, the "Old Man" got a joke on us. I don't think he meant to, but he did it just the same.

You see he has a bad habit when he comes down through the room; if he sees a press running and the work lying near it, he will take a piece and shove it under the punch and put his foot on the treadle—just the same as a boy gives a crank a turn because he likes to see the wheels go round.

Well, Bill had just finished blanking out a lot of sprockets in the big press—the one with the gear—and he had started taking out the dies. He loosened up the bolts and pulled the bed ahead about an inch, and then the boss called him to give him a lift on a die bed, and he went off and left the press running. That is a thing he ought never to have done anyhow, and as bad luck would have it, just then the "Old Man" came along. There was a piece of stock laying there which was too short to make a full blank, so Bill didn't blank it out. The "Old Man" laid it on the die, and put his foot on the treadle. Of course it didn't punch it; it just nipped it between the end of the punch and the face of the die; and it brought that big press up all standing. The "Old Man" gave one look and went over to the boss and said, "That big press is stuck, and you had better get it off the center," and off he went.

Bill and the boss went over to the press and tried to get it off the center by holding back the clutch and then starting it up, and when it got at full speed, letting go the clutch. Almost always that will do it, but in this case it was too far back of the center, so they tried crossing the up-and-down belt, and then doing the same trick with the wheel running backward, but it was no use—it wouldn't budge a bit. Just then the whistle blew, but, as it would never do to leave a press stuck on the center all night, that whistle didn't cut much ice with us. As it may interest some of your readers to know how we did start it, I will go into detail a little.

We took out all the bolts that held the slides to the bed of the press, and then we went out in the yard and got a long piece of timber and drove the die bed and bolster out from under the punch by main force. It was hard work, but it did the business, and I know of no better way to do it when a press is stuck just back of the center as this one was.

It was about 10 o'clock when we got through, and as we went out I said to Bill," "The joke ain't quite as good as it was the last time the "Old Man" came through, is it?"

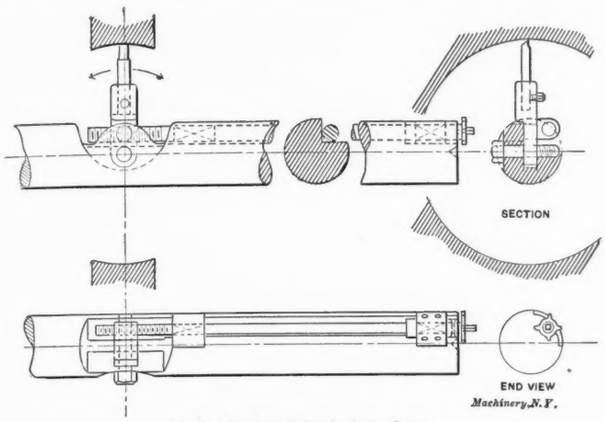
* * *

Not every wild statement of the daily press is as easily disproved as one published recently in a New York paper describing a new telegraph cipher code book which was claimed to contain 1,020,000,000 pronounceable words with at least two letters difference. In addition, it was claimed there were 160,000,000 extra words all arranged in alphabetical and terminational order, the whole being contained in one volume quarto size. The editor of the *Western Electrician*, being somewhat suspicious that this statement was not entirely within the bounds of truth, has done a little figuring, and tells us that allowing, say, 5,000 words to a page this volume must contain 236,000 pages, which would make a book over 39 feet thick—a truly ponderous tome!

LETTERS UPON PRACTICAL SUBJECTS.

A SPHERICAL BORING BAR.

The writer on his travels among the different shops happened on a very useful and interesting boring bar for boring spherical holes or rather ball-and-socket joints in pillow blocks, which, in his opinion, is hard to beat. The inclosed sketch is clear and needs no special explanation. This bar can be used either in a lathe or horizontal boring machine. The work of this bar, compared with that done on the vertical boring mill, is done better and more economically. The bar was seen in



Rig for Boring Spherical Surfaces.

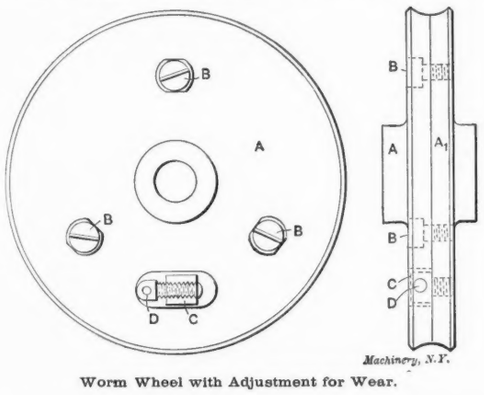
operation on a floor boring machine at the Geo. V. Cresson works, Philadelphia, and so far as the writer could learn, is only used in this shop and the Pelton Water Wheel Co.'s shop in San Francisco, Cal. It is simple and easily constructed. The toolholder swings on a pivot pin and is fed either way by the screw and nut, the nut being set in toolholder so as to accommodate itself to the screw as the holder moves back and forth. The feed screw is held in the slot by two bearings.

WARD.

[Our correspondent doubtless refers to specific construction when he says that this bar is used only in the two shops named. Spherical boring bars of slightly different form are in quite general use.—EDITOR.]

SPLIT WORM WHEEL.

The accompanying cut shows a split worm wheel which I think is of considerable interest to the readers of MACHINERY. It has 160 teeth and a pitch diameter of 10 1/16 inches, and a thickness of 1 3/16 inch. It is made of 2 plates, $A\,A_1$, 19/32 inch thick, which are held together by 3 fillister head screws, B, which go through slotted holes in plate A and into screw holes in plate A_1. Half the worm wheel is keyed to the



Worm Wheel with Adjustment for Wear.

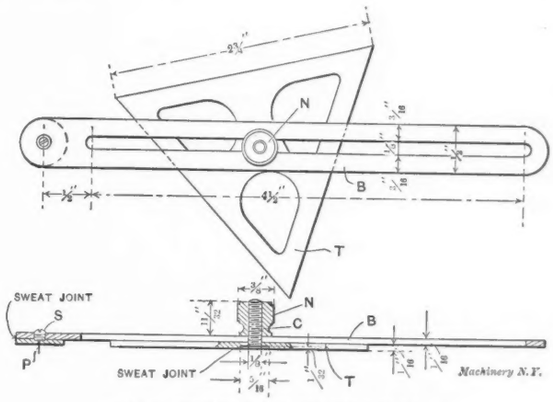
shaft and an adjusting screw, D, and stud, C, are provided for changing the relative position of the two halves of the wheel. The worm wheel is made in the usual manner, being put on a mandrel and hobbed out just the same as if of solid stock. The split feature is to take up the wear incident to use. When the teeth wear the screws are loosened and the adjusting screw is set up turning one plate by the other and thus taking up all the wear so that there is no back-lash with the worm. In this way it can be used until the worm is nearly worn out, still having no back-lash. This type of worm wheel is used in a cam cutting machine for sewing machine work where back lash must not exist, and the action must be perfectly smooth.

G. E. H.

TOOL FOR LAYING OUT RATCHET TEETH, TANGENTS, ETC.

The sketch shows a little instrument which I have found to be a great timesaver and aid in my work as draftsman and designer. Just where the little tool originated and whether or not it is on the market I am unable to say, but I have found it such a serviceable and desirable instrument that I know others will be glad to learn of it.

It is used in putting in both radial lines and tangents about a given center, as in drawing the teeth of a ratchet wheel, etc. The slotted bar, B, has a pin, P, held in one end of it by the screw, S; this pin is stuck into the paper at the given center, the triangle, T, is shifted lengthwise of the bar and turned



Tool for Drawing Radial and Tangent Lines.

about the screw, C, until one of its sides takes the direction of the radial or tangent which it is desired to repeat about the center. The triangle is then clamped firmly in position on the bar by means of the knurled nut, N, and then by swinging the entire instrument about the fixed pin, the edge of the triangle is brought to the successive positions at which it is desired to put in the required lines. The slotted bar, B, may be made longer than it is here shown, but for all of the work on which we use it, the length shown is sufficient.

Dayton, O. CLAUDE T. JOHNSON.

BRIGHTENING AND COLORING BRASS.

The work to be brightened and colored is first annealed in a red-hot muffle or over an open fire, allowing the cooling to extend over one hour, the object of the heating being to remove the grease or dirt that may have accumulated during the process of fitting. Soft soldered work, however, must be annealed before being fitted together, and afterward boiled in a potash lye. This is also done with work having ornamental surfaces. Next it is immersed in a bath of diluted oil of vitriol or aquafortis, either of which may be made with two or three parts of water and one of acid, but the old acid that contains a small quantity of copper in solution is frequently preferred. The work is allowed to remain in this liquid for one or two hours, according to the strength of the acid. It is then well rinsed in water and scoured with sand, which is applied with an ordinary scrubbing brush, and washed. The pickling bath is made by dissolving 1 part of zinc in 3 parts of nitric acid of 36 degrees, Baume, in a porcelain vessel and adding a mixture of 8 parts of nitric acid and 8 parts of oil of vitriol. Heat is then applied and when the liquid is boiling the work is plunged into it for half a minute or until the violent development of the nitrous vapor ceases and the surface is getting uniform. Then it is plunged into clean water

and well rinsed to remove the acid. The ordinary dark grayish yellow tint which is thus often produced is removed on immersing the work again in aquafortis for a very short time. Then it is plunged into clean and slightly alkaline water, well rinsed to remove the acid and plunged into warm, dry beech or boxwood sawdust, and rubbed until quite dry. To prevent the action of the atmosphere it is lacquered; if a green tint is to be produced, the lacquer is colored with turmeric. A dark grayish but agreeable tint is obtained by immersing the work previously in a solution of white arsenic in hydrochloric acid, or in a solution of bichloride of platinum with a small addition of some vinegar, or rubbing with plumbago.

Rochester, N. Y. JOSEPH M. STABEL.

BORDER LINE PEN.

The accompanying line cut and halftone illustrate a very clear arrangement of a border line pen, which to my mind is the cheapest and most simple scheme that I have ever seen. It is made by taking any old ruling pen, particularly one un-

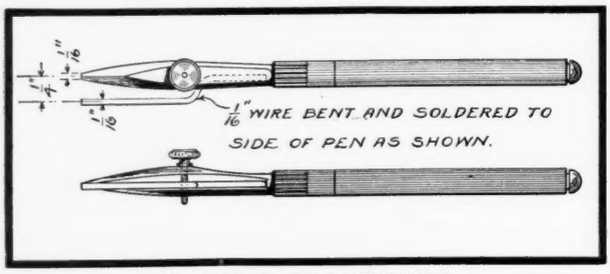


Fig. 1. Drawing Pen for Wide Lines.

fitted for further use and fitting a piece of steel or spring brass wire in the middle of the pen and soldering it to the fixed half of the pen; then both pen and wire are ground off until the former is of whatever standard width line you may wish, preferably one-sixteenth inch. Then smooth the points on an oilstone by holding the pen perpendicular, as shown in Fig. 2.

By having a pen of this kind in every drawing room a uniform width of border line is fixed. The advantage of

Fig. 2. Method of Using Pen.

uniform border lines on all tracings is apparent, especially when you know draftsmen who, when left to their own judgment have made them as wide as ¼ inch.

Fig. 2 shows the manner of holding the pen while using; the pen is held perpendicular and with the wire against the T-square, which not only allows the draftsman to see what he is doing, but also prevents the ink from running under the edge of the T-square.

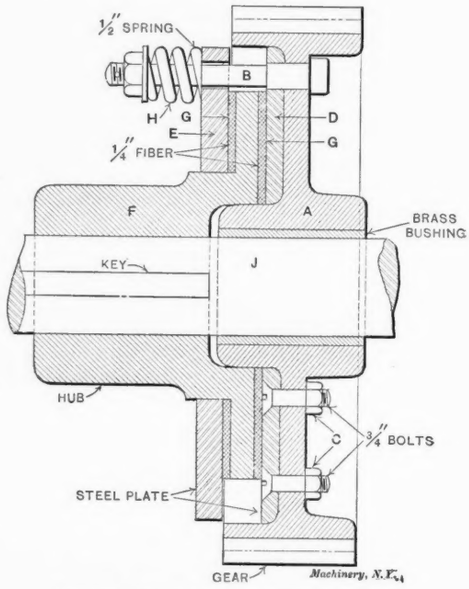
The border around Fig. 1 was made by the pen I use right along. ALBERT P. SHARP.

Williamsport, Pa.

[The cut, Fig. 1, is a photographic reproduction of a drawing made by Mr. Sharp, the original being 6 inches long.—EDITOR.]

IMPROVISED SLIP GEAR.

The accompanying cut shows an ordinary spur gear after having been transformed into a friction or "slip" gear to prevent breakages. The gear is used on the inspection bed pull-up of a large structural steel mill to drive a drum on which is wound a cable. This cable in turn drags the I-beam channels or other product of the rolls to one end of the inspection bed by means of dogs, the product sliding on rails or skids. Owing to carelessness on the part of the operator in not stopping the motor in time to prevent the collision of the beams pulled up with others already at the end of the bed the gears were broken quite frequently, so it was determined to provide means for slippage to prevent these breakages. As the gears were steel castings and a supply of them was on hand it was decided to convert them into slip gears, which was done in the following manner:



Friction Slip Gear used to Prevent Breakages.

The web, rim and hub of the gear were machined on one side, and a ¾-inch steel plate *D* was turned to fit. This plate was bolted onto the gear with 8 countersunk bolts, *C*. Eight steel pins, *B*, with nuts and split cotters were fitted through the web and plate, projecting on the machined side of the gear so as to make space for the coiled springs, *H*. A hub, *F*, with a turned flange, was made and fitted over the end of the gear hub, which latter had previously been bored out and bushed with a brass bushing; the hub *F* was keyed to the shaft *J*. Another steel plate, *E*, 1¼ inch thick, was bored out to a sliding fit over the new hub, this plate having holes drilled to correspond with the 8 pins in the web of the gear, the holes being a loose fit for the pins. A ¼-inch fiber disk was put between the hub flange and the steel plates on either side to form wearing surfaces. Springs made of ½-inch wire were put on the pins and tightened to the required pressure. The new hub was keyed to the shaft, thus making practically a "fool-proof" arrangement, as the master mechanic of the mill expressed it. Whether it answers this description or not, we know that we have had no further trouble with broken gears since. BESSEMER.

WHAT THE BRASS CHECKS SAY.

By looking over the brass check board in the tool room we often find that certain checks stick to their respective hooks as if they were melted together. Upon asking the toolroom keeper about those checks we may be sure to get something like the following answer: "That's a lazy fellow—'Old Bill'; he don't care about returning tools." But "Old Bill" cares more than it seems. He simply looks after his own interest and at the same time after that of the company. Further investigation shows that Bill has a hacksaw, ratchet wrench, two sets of taps, etc., the most of which he has had in his possession for about a quarter of a year, and seems to have forgotten about returning same. At the same time Bill's neighbor on the bench comes along returning a tool with the words "that's no good" and, dissatisfied, goes back to his work. Bill working not far away hears his re-

mark and smiles. Why? Well, he has got the best hacksaw there is in the whole toolroom, and a lot of other first-class tools from the toolroom. The rule says that a tool should be returned as soon as the job is finished, but can you blame Bill for not doing so? Very likely not. But who is to blame that his fellow workmen don't get a chance of using these tools? No one else but the toolroom foreman for not inspecting the tools from time to time. If he would attend to his duty and have the tools fixed up, sharpened, ground, adjusted as they ought to be, there would be no complaint about a tool not being satisfactory, and no workman would keep the real good ones in his tool-chest. By doing as above, the foreman would help the company and the workmen to make more money, because everybody knows that working with a first-class tool saves time, and time saved is money saved. This is the story the seemingly forgotten brass checks tell, if we only want to listen to them. GEORGE WILLIAM BOEHLER.

Forrest Hill, Mass.

BORING BAR CUTTERS.

The proper interchangeable flat cutter for boring bars is a subject of more or less general interest. Upon visiting quite a number of different shops as many kinds of boring bars with inserted or attached cutters may be found, with the exception that the majority of ordinary bars will have the cutters held in by a drive wedge or key. In some shops a set screw is used. Neither of these holds the cutter securely without undue strain, which is apt to, and very often does, spring the bar out of true.

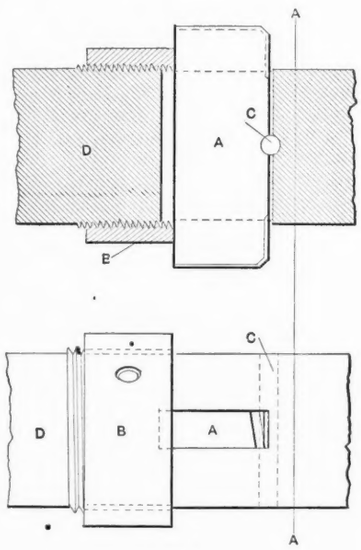


Fig 1.

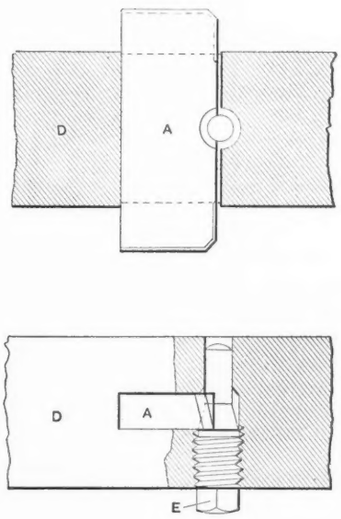


Fig 2.

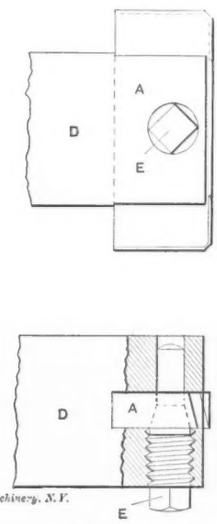


Fig 3.

Fig. 1 shows a method of holding cutters, which although not new, is not generally known nor used on boring bars and counterbores as much as it should be, being well adapted to general use. Cutter *A* is centered by pin *C* and clamped by collar *B*, which screws on bar *D*, the thread being right- or left-hand, as may best suit the work. Fine thread should be used. Line *A A* represents end of bar when it is desired to use this form for chucking work or end boring.

Fig. 2 shows a method of holding a flat cutter by a single screw *E;* this screw both locates and secures the cutter *A*. It affords a simple and handy means of holding flat cutters set central; and fly-cutters are easily held so they can be adjusted by making the cutter enough narrower than the length of slot to allow for a gib under the side of the screw. The gib should have a half-hole same as cutter shown to prevent crawling when tightening the screw.

Fig. 3 shows the same cutters as Fig. 2 used in the end of a bar for use on boring mills and chucking work of general character. As is shown, this construction allows the cutter to project beyond the end of the bar, thus making it useful in squaring the bottom of a hole or boring to a shoulder. This method is also used for counterbores by adding a pilot on the end of the bar. On all cutters of this kind the best general proportions are: Thickness equals ¼ diameter of bar, plus 1/32 inch; width equals 2/3 diameter of bar. M. S. W.

HARDENING TRANSMISSION CHAIN PINS.

In the manufacture of transmission chains it is now customary to harden the different parts before assembling, to avoid, as far as possible, the lengthening of the chain by wear. It was found to be a simple matter to harden the blocks, or rollers, as the case might be, but to properly harden the pins or studs was a horse of a different color, so to speak. The conditions confronting the manufacturer were, that the body or bearing portion of the stud must be hard while the reduced ends outside the shoulders must remain soft enough to rivet, as indicated in Fig. 1. To these unusual conditions was added still another, namely, that the process must be comparatively cheap. Upon investigation there were found to be a number of different ways by which the desired result might be accomplished. Which particular way was finally decided upon I cannot say, as I was not present; but my way, which is good enough for me, is as follows:

Fig. 1. Fig. 2.

Pins with Hard Centers and Soft Ends.

The studs are first produced in the usual manner, by automatic screw machines, from dead soft crucible steel wire. After cleaning they are thrown into the revolving hopper of an automatic electric heating machine, which is operated by a cam-shaft geared five to one with the driving pulley and carrying the necessary number of cams to operate the mechanism. A tubular collecting arm, or trough, the end of which dips at regular intervals into the horizontally revolving hopper, collects the studs and deposits them by the return tip of the arm into the top of a short vertical tube where they stand end to end in a solid column. Next an arm carrying spring fingers at its outer end swings back and forth between the lower part of the vertical tube where one stud at a time is exposed to the clamping dies, which clamp the studs endways as they are presented between them by the spring fingers of the carrying arm. Now these clamping dies are the terminals through which a current of 10 volts and 500 amperes flows, and is timed by a cam actuated make-and-break contact after the clamping dies have the stud clamped firmly between them. After being brought to the proper heat, which is almost instantly, the dies open and the current is shut off simultaneously and the hot studs are dropped into a tank containing a solution of salt and water. The result of this treatment is

that the ends of the stud, being clamped endways between the cool faces of the dies, which are large enough to carry the current without heating, are necessarily too cold to harden, while the body of the stud between the shoulders, being further away from the cold dies, receives a hardening heat as indicated in Fig. 2. The darker portion of cut shows the hard part and the lighter portions the soft ends.

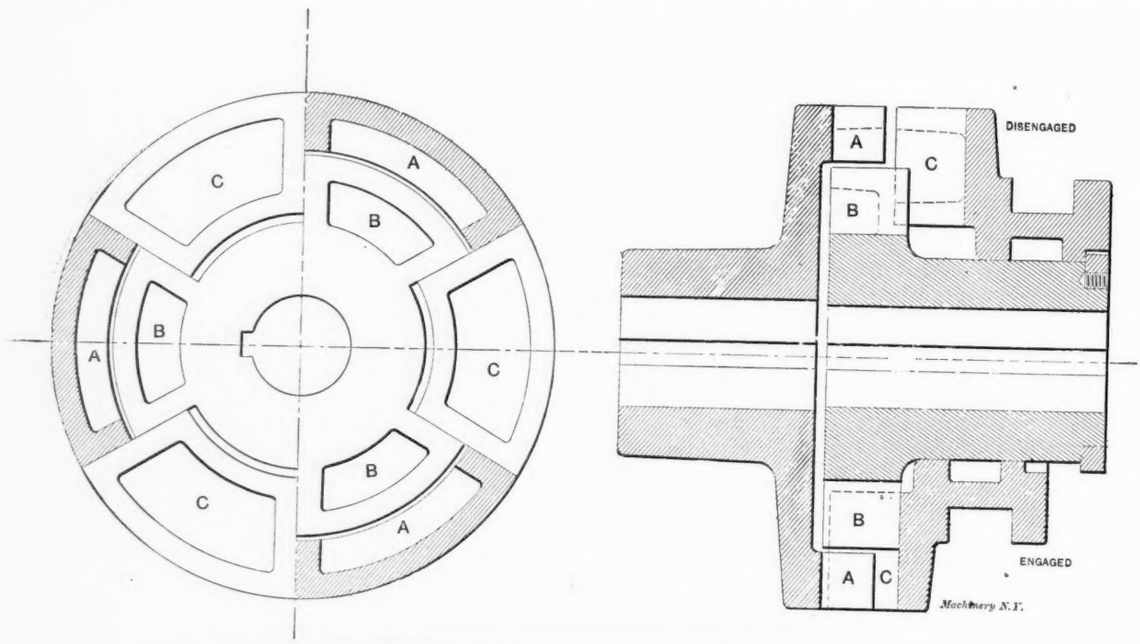
The capacity of the machine is fifteen hundred studs per hour, and it requires but very little attention. BRISTOL.

[The foregoing described method of annealing the ends of chain studs is practically the converse practice of that of one well-known chain-making concern. The practice of this concern is to heat the pins in a furnace and to harden them by dipping in a bath in the usual manner, and then to anneal the ends by an electrical process by which carbon electrodes in contact with the ends of the pins, raise them to a red heat so quickly that the body of the pin is not affected. In this way the hardness of the body is not changed while the ends of the pins are softened sufficiently to admit of riveting over.—EDITOR.]

A TOOTHED CLUTCH.

A great inconvenience connected with the tooth-clutch in common use is the necessity of having one of the two parts—advantageously the driven one—sliding on the shaft, in order to disengage the clutch. This lack of a firm connection between clutch, key and shaft results in a tendency to turn the key out of its bearing and, when disengaging is done under full pressure, as is generally the case, in a wearing off of the sides of the key. The application of two keys lessens this inconvenience, but does not abolish it. The accompanying illustration shows a tooth-clutch which avoids the sliding on the key, having both parts, the driving part *A* as well as the driven part *B*, firmly keyed to the shaft, while the engaging between the two parts is performed by a third part *C*, which slides on the hub of *B*, but cannot revolve around *B*. The upper half of the illustration shows the clutch disengaged, the lower half engaged. As can easily be seen, the teeth on the driving part *A* are arranged on a larger circle than those in the driven part *B*, so that part *A* may freely revolve around *B*, while the teeth on the third part *C* slide in between those of both *A* and *B*. As soon as *C* is shifted toward *A*, the teeth of *A* and *B* are connected by those of *C* and the power is transmitted to the driven shaft. Thus the hub of the sliding part *C* has nothing to do with the transmission of power and motion, and serves only to shift the teeth into proper position.

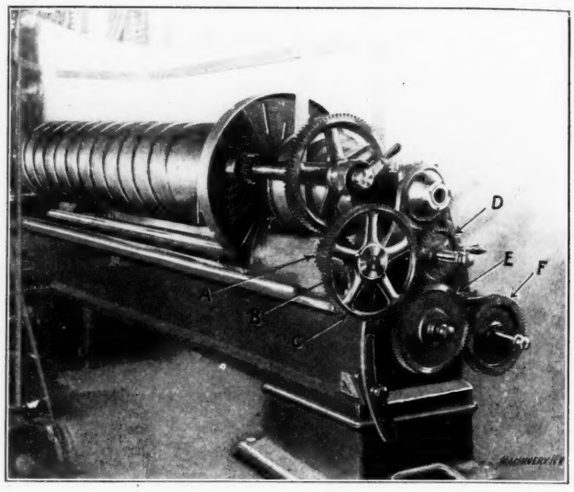
Philadelphia, Pa. ALBERT GOTTSCHALK.



Tooth Clutch with both Driving and Driven Members Keyed Securely to Shaft.

HOW A COARSE PITCH SCREW WAS CUT.

The accompanying photograph shows a Fay & Scott standard 32-inch lathe geared to cut a 16-inch pitch thread. A lathe of this size would hardly be expected to cut as coarse a thread as this with the ordinary method of change gears. It was accomplished in the following manner:



Lathe Geared for Cutting Coarse Pitch Screw.

The ratio of back gears on this lathe was 12.564 to 1. That is, one revolution of the spindle required 12.564 revolutions of the head cone. The pitch of the lead screw was one inch. To get a feed to the carriage then of 16 inches would require that the screw make 16 revolutions to one revolution of the spindle, or 12.564 revolutions of the cone.

B is a bearing bolted to the bed of the lathe carrying an intermediate shaft, on which was mounted gears *A* and *C*. Gear *A* meshed into the regular back gear which simply served as an intermediate between the cone pinion and *A*. Gears *D* and *E* are intermediates, *D* being a regular change gear on the headstock intermediate spindle. These two intermediates were required for cutting left-hand threads. When a right-hand thread was being cut the gear *D* was removed, and *E* brought up into mesh with *C* and *F*. The gearing arrangement then was as follows:

Let the cone pinion be represented by *G*.

Then revolutions of cone pinion $\frac{G}{A} \times \frac{C}{F}$ = revolutions of

the screw, or $12.564 \times \frac{26}{27} \times \frac{92}{69} = 16.1$, which was near enough to the desired result. With this arrangement the lathe had ample power for cutting this coarse thread.

The thread in question was cut on a steel roll 20 inches diameter by 10 feet in length. These were double square threads 1 inch wide by ¼ inch deep. Into these grooves were wound cold-rolled steel 1 × ⅝ inch. This steel was wound in cold by means of rolls arranged on the tool block, and it had to be fastened with screws at every 18 inches to keep it from springing out of place. The rolls were for use on a patent log hauler for winter use designed to screw its way through the snow, and take the place of the traction engine. These screws were manufactured at the works of Fay & Scott, Dexter, Me. W. L. FAY.

Dexter, Me.

THE EVOLUTION OF A CUTTER TO REDUCE TOOL-MAKING COST.

In making a cast-iron slide having concave and convex cuts high-speed steel milling cutters were adopted to reduce manufacturing cost. The cost of making the cutters for a lot of slides was considered to be quite an item, hence the change in the design of the cutters to reduce the tool-making expense. The cuts, Figs. 1, 2, 3 and 4, illustrate the evolution of the cutter to the present form in order to make the cost of maintenance as low as possible. The design of the slide required a certain diameter, form and length of cutter, proportions of which are indicated in the cuts.

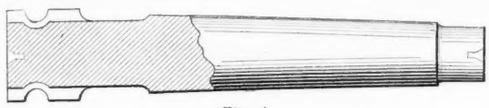


Fig. 1

Fig. 2

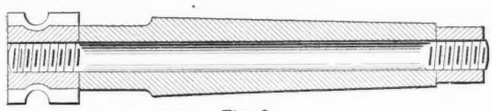


Fig. 3

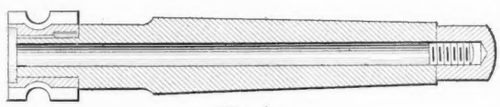


Fig. 4

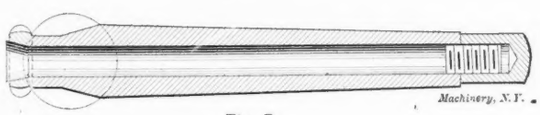


Fig. 5

Different Methods of Cutter Construction.

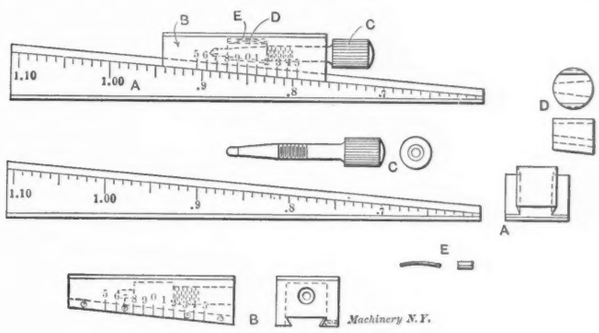
Fig. 1 illustrates the first cutter made and it is the most expensive, being solid, which required the grinding of the shank end as well as the cutter end after hardening; the cost of the steel (Novo), turning, milling the teeth, hardening and grinding, made the cost of this cutter quite high. In Fig. 2 the objection to the construction is the difficulty of releasing the cutter from the arbor and the liability of springing the threaded end, which is weak, because of the reduction of area due to cutting the thread. The cutter shown in Fig. 3 was made with a rod through the shank and a nut at the small end of the shank to draw the cutter up tightly against the shank, and to release it readily without springing; the objection to this design is the changing of the thread in the cutter in the hardening process, and this trouble also occurred in Fig. 2. Fig. 4 shows how these faults were corrected by making the cutter with a keyway or spline, and fitting it on a reduced diameter of the shank itself. The bolt is made with a thin head and the nut at the opposite end is made with a cap to protect the thread when knocking the cutter out of the spindle. The bore in the cutter is lapped to fit the arbor closely.

The convex cutter is shown in Fig. 5, and its construction is similar to Fig. 4, with the exception that it has a taper hole and rod to fit. A slot is milled for the tongue or key on the arbor as indicated by the dotted circular line with a saw 1 inch in diameter and 1-16-inch thick. The rod should be a close fit at the cutter end to insure a rigid support. The hole being tapered in the cutter there is no need of lapping, as is the case in Fig. 4. A. C. LINDHOLM.

Prince Bay, S. I.

PARALLEL VERNIER GAGE.

The cut shows a parallel vernier gage that has proven to be very handy in measuring when lapping and milling snap gages; it can also be used as a small height gage to measure the distance from a shoulder to the base on planer or milling machine work. After a snap gage has been ground or lapped in a machine to within, say, 0.0005 inch it must be hand-lapped, for a slight tipping to one side or the other is bound to occur in the machine and as a consequence the surface becomes belly-shaped. The tool illustrated is used in connection with the lapping in order to get perfectly straight and parallel surfaces. It has a rise of ½ inch in its length from 0.600 to 1.100 inch, and it may be used for any greater height by fastening half-inch blocks on top of the slide with screws. If such blocks are used they must be hardened, ground and lapped true. The slide *B* is made of tool steel and is composed of two pieces. The top plate is hardened and ground and soldered on. Four small screws hold the gibs in position and provide adjustment; the tapered knurled screw *C* serves to lock the top slide at any point on the base *A* by lifting the binder *D* which is slotted on the under side to fit the dovetail on *A*. The flat spring *E* is placed in the top of the hole in *B* in order to push the bushing down clear of the dovetail *A* so that the slide *B* may move freely when released. A 1-32-inch hardened sheet steel plate is also soldered onto the bottom of the base *A*, thus forming hardened working surfaces on top and bottom. The tool is ground square and parallel all over, and the top and bottom are lapped, care being taken to have the sliding parts scraped straight in order that the measurements will register correctly for all settings.



Toolmakers' Depth or Width Gage.

When it is finished and assembled, the graduations should be marked. This can only be done by hand. Mark the slide *B* in the center with a zero line and locate it at 0.600, 0.700, 0.800, etc., positions on the base by using a micrometer, and mark each position with a line and the proper figures as shown in the cut. Then divide each space into ten equal parts. To make the vernier the top scale must be laid off so that ten spaces cover the distance of eleven on the lower scale, 5½ of the divisions on the lower scale being on each side of the zero line when set as shown in the cut. The divisions on the vernier should be numbered from 1 to 5 on the right-hand side and from 5 to 9 on the left-hand side of the zero mark. It

will thus read in tenths, hundredths and thousandths. The graduation of the instrument is similar to that of vernier calipers and is read in the same way, but is much plainer on account of the places being wider; in the position shown the gage reads 0.850 inch. If one, or more thousandths, is wanted move the slide along until 1, 2, 3, etc., meet the corresponding lines on the bottom scale.

Under no circumstances should this tool be hardened, as it will warp so that it is impossible to lap it straight. This is the reason that the hardened steel plates are soldered on top and bottom so as to give it a hard surface on the principal wearing parts.

O. WESTBERG.

CUTTERS OF COLD-ROLLED STEEL.

Herewith you will find a blueprint of an adjustable reamer such as used by the Jones & Laughlin Steel Co., for reaming the bore of pulleys, etc. The cutters of these reamers are of common cold-rolled steel, case-hardened, and give as good service as ones formerly made of the more expensive grades of steel. The formula used for case-hardening is as follows:

Use Rogers & Hubbard Co.'s (Middletown, Conn.) No. 2 granulated raw bone; pack the cold-rolled steel in cast iron box with one-half inch layer of raw bone all around; cover box and close up with fiber clay. Heat in a gas furnace at almost white heat for from two to five hours; draw the steel, and dip quickly in the following mixture:

One quart of vitriol, 4 pecks of common salt, 2 pounds of saltpeter, 8 pounds of alum, 1 pound of prussiate of potash, and 1 pound of cyanide of potash. Dissolve this in 40 gallons of soft water. Care should be taken not to breathe the fumes coming from the cyanide of potash, as they are very poisonous.

F. WACKERMANN.

South Pittsburg, Pa.

MAKING TIN TUBES.

The brooder and incubator trade calls for a large number of tin tubes, usually of 1 inch diameter, about 4 inches long and folded on one or both ends. Several requests have come in for information on the making of these tubes, and this is sent you with the sketches to satisfy that demand.

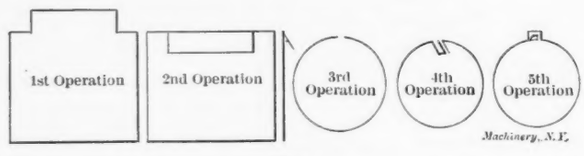


Fig. 1.

The blank is usually cut out as shown in the first operation, Fig. 1, the corners being cut away to allow for the folding process which is shown in the second operation, and the tube is then rolled to the shape shown in the third operation.

While these three operations can easily be made with press tools, unless the quantity wanted is very large, there is a saving on the tool-making end by making them with an ordinary tinsmith's outfit. The fourth operation, bending the lock is done on the die shown in Fig. 2. The tube is slipped on the mandrel *A*, each edge of the tin being forced up against the stop *B*, and one stroke of the press forms both ends into the shape shown by the fourth operation in Fig. 1.

The tools shown in Fig. 3 are for the fifth and last operation. The tube can be formed with the seam on the inside or

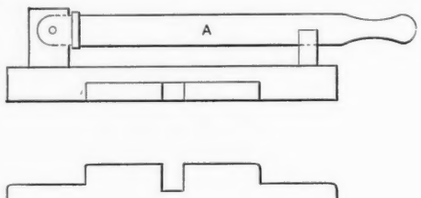


Fig. 2

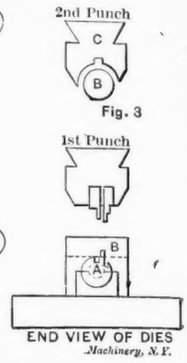
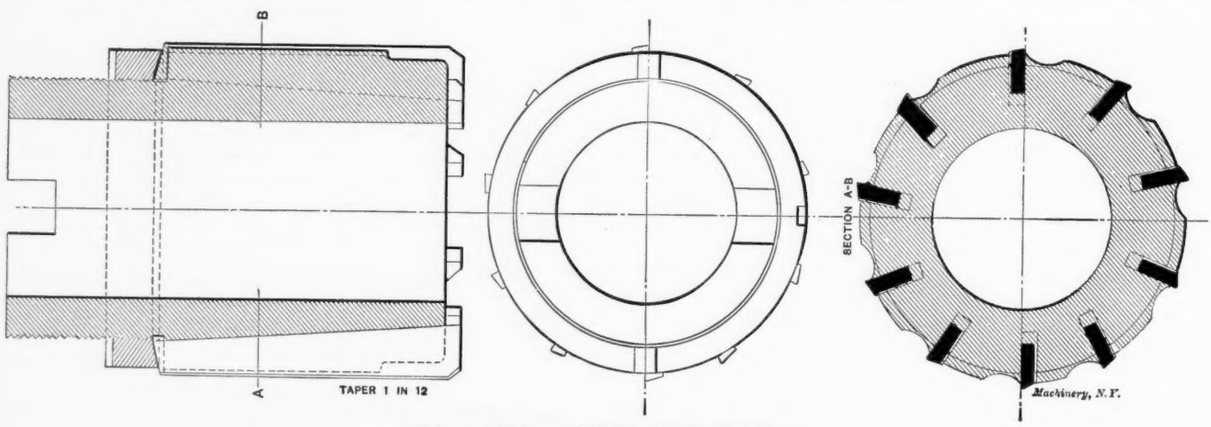


Fig. 3

on the outside by making the necessary change in the arbor and closing punch. While the tools can be used in any ordinary power press, the best results can be obtained in a short-stroke foot press, as the work can be handled to better advantage and the cost of the dies is less. These tubes cannot be drawn from tin as it is difficult to draw the depth more than equal to the diameter of the tube. A good grade of tin will stand two drawings, and in exceptional cases, three; but that would be too short to give the desired length in this case.

Bridgeport, Conn. J. L. LUCAS.



Cutters with Inserted Teeth of Cold-rolled Steel.

LOCATING DEVICE FOR SCREW SLOTTING ATTACHMENT.

Having had many years experience of a more or less difficult nature in the capacity of foreman of a large hand and automatic screw machine department, there have been times when the conditions connected with certain work required the working out of new ideas, which, when put into practice, simplified matters considerably in manufacturing certain parts. Such little devices, in this or other shops, receive no notice outside of the place in which they have their origin, even though many factories throughout the country might have similar conditions to deal with. I would like to call the attention of the readers of MACHINERY to a device for locating work having flat sides, in the holder of the screw slotting attachment used on the Brown & Sharpe automatic screw machine. I have used the attachment about to be explained for the past ten months with excellent results and can therefore vouch for its efficiency.

I have at present two automatic machines making screws of flat stock, which, as shown in Fig. 1, have to be slotted parallel with the flats. A sketch of the attachment to which I desire to call attention is shown, enlarged, in Fig. 2. This illustrates the device as completed, but represents it with the

face milled off, as shown by the section lining, on a vertical plane through the center line of the screws and spring plungers; an axial section is shown in Fig. 4. The hole *A* is for the screw which fastens the holder to the arm of the slotting attachment. The hole at *B* is for the bushing which holds the screw while it is being slotted. This hole is made tapered to fit the bushing which is shown at *D* in Fig. 4 and in end view in Fig. 3. Slot *C*, which is shown in both Figs. 2 and 3, is cut the full length of the bushing and permits the passage of the ejector or stationary blade which pushes the finished work out when the slotting arm with the holder and bushing attached drops back from the saw. Bushing *D* may be made

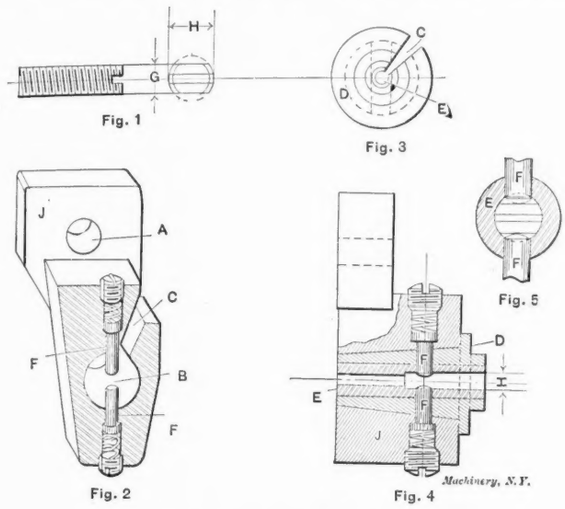


Fig. 1 Fig. 3 Fig. 5 Fig. 2 Fig. 4

Locating Device used in Slotting Flat-sided Screws.

from the regular one furnished with the attachment, internal bushing *E* being driven into it to fit it to this particular job. Holes for the plungers *F F* have also to be drilled.

In Fig. 4 is shown a cross section of the holder with the bushings inserted and the parts in the position they occupy when the holder is empty. Spring plungers *F* are pressed by the springs on their heads to the full depth of the counterbore in which the heads are seated, leaving a space between their points a little less than the width *G* of the screw shown enlarged in Fig. 1. The diameter of the hole *H* is about 0.001 inch larger than the same dimension on the screw. The depth

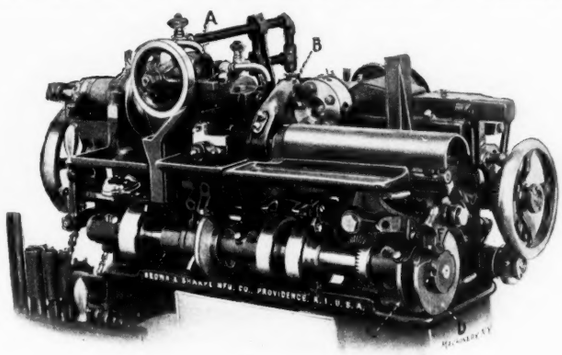


Fig. 6. Brown & Sharpe Automatic Screw Machine with Screw Slotting Attachment.

of this hole is sufficient to allow the head of the screw to project a slight distance further than the depth of the slot beyond the bushing.

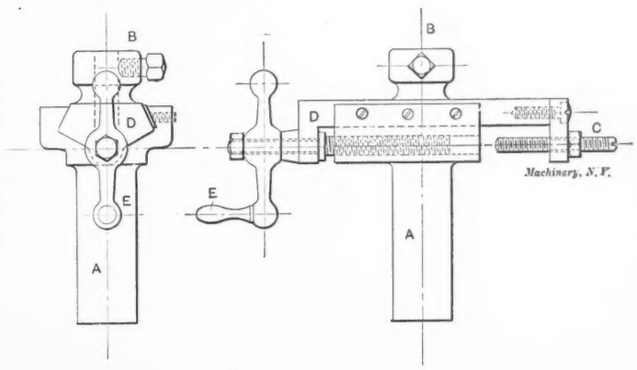
In operation the holder *J*, with its bushing *D*, is pushed over the work as it revolves in the chuck just before it is severed from the stock. As the piece revolves, plungers *F* ride over the contour of the work, rising as they pass the full diameter and coming together at the flats. When a piece is almost cut off, the tension on the two studs will be sufficient to break it from the stock and hold it in position by the two flats as shown in Fig. 5. The work is then in position to be slotted with a cut parallel to the flat sides. PHILIP STERN.

Hartford, Conn.

[Perhaps the accompanying halftone and description will show more clearly the slotting attachment referred to and lead to a better understanding of the device described by Mr. Stern. In Fig. 6 is shown a Brown & Sharpe automatic screw machine with slotting attachment. The saw is shown at *A* and this is driven by an independent round belt from the countershaft above. Arm *B* carries the holder shown in Fig. 2 with its bushing, Fig. 3, for holding the work. This arm has two movements, a reciprocating motion lengthwise of the machine and a swinging motion about its longitudinal axis as a center. These two movements are controlled by cams *C* and *D* respectively. As the work is about to be severed by the cutting-off tool, arm *B* is swung down by the cams until the bushing Fig. 3 is in line with the spindle. It is then advanced to encircle the work. Immediately after the severing of the screw by the cutting-off tool, arm *B* is swung upwards by cam *D* until the screw which it carries is in line with slotting saw *A*. Cam *C* then again comes into play and feeds the screw up to the saw and slots it. The arm and bushing are then dropped back, during which action an ejector passes through slot *C*, shown in Figs. 2 and 3, thus pushing the completed screw out of the bushing. While this slotting has been going on the main turret has, of course, been at work on a new piece, which is received in turn by the arm *B* and carried to the slotting saw.—EDITOR.]

RECESSING TOOL FOR SCREW MACHINE.

I show herewith a sketch for a recessing tool for a screw machine or turret lathe. This device has a wide field and can be used for recessing, or for cutting a groove in a hole of any size, as well as for boring or squaring up a piece in a chuck where it is necessary to use the back and front cross slide tools for other purposes; altogether I find it a very satisfactory tool to use. *A* is a shank fitted to the hole in the turret of the screw machine. The front end of this piece is



Recessing Tool.

machined to form a bearing for the dove-tailed slide *D*, which is operated by handle *E* and the attached screw. It is quite necessary that this slide be exactly at right angles to the center line of shank A. Projection *B* on *D* is provided with a hole suitable for the tool it is required to use, being round or square as the case may be. The movement of the slide is limited by the stop *C* in a way that will be readily understood. J. S. S.

* * *

The economy of the steam engine is much enhanced with superheated steam and happily the use of superheated steam with the steam turbine is much more practicable than with reciprocating engines. One reason for the superior efficiency of superheated steam aside from purely thermodynamic cause is the lessened retardation of the wheel due to loading with condensation. Prof. Thurston pointed out a number of years ago that the energy absorbed by a single drop of water falling on the periphery of a turbine wheel 10 feet diameter running at 500 revolutions per minute amounts to 67.7 foot-pounds; with saturated steam, the condensation may be as high as 20 per cent., hence the loss from mechanical retardation alone might be a very important item in turbine economy, although not as great as indicated above, for improved turbines do not run at any such peripheral speed as 15,700 feet per minute.

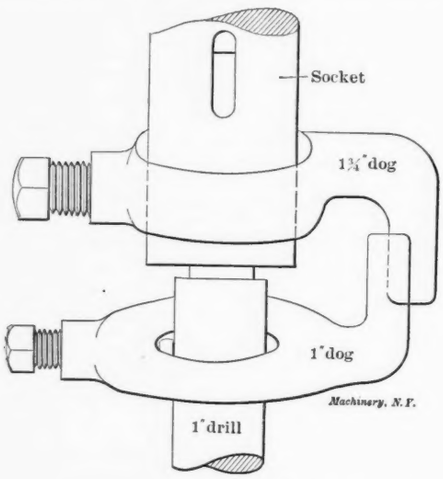
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

EXTEMPORIZED DRIVER FOR TWIST DRILL.

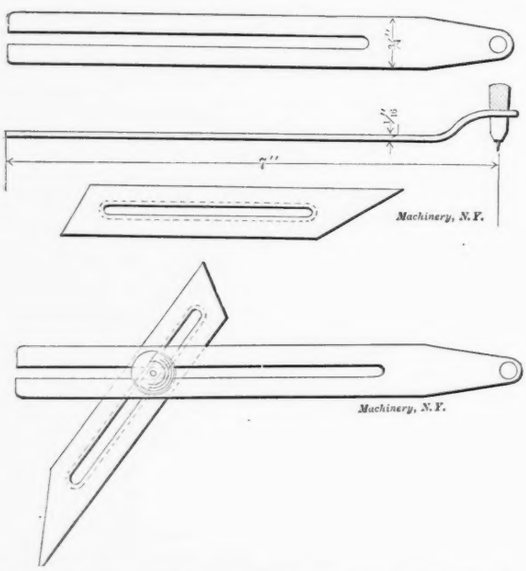
One of our apprentices twisted off the tang of a 1-inch twist drill the other day; and it being the only 1-inch drill on hand, and as he had quite a few more holes to drill he had to use the drill as best he could. He had a hard time of it at first,



for no matter how hard he drove the drill in, it would turn round in the socket until "Old Pop Deming" took pity on him and helped him out. The sketch shows how "Pop" helped him out, and it needs no explanation. It may be of service to apprentices who read MACHINERY. C. F. EMERSON.

DRAFTING TOOL FOR SKETCHING RATCHET TEETH, ETC.

The sketches show an extremely useful little drafting tool which any mechanic can make in a short time. I used the slotted blade from a Starrett universal bevel (the blade which has the ends beveled to 30 and 60 degrees), also the clamping screw and nut. The other part is made from a piece of ¾ x 1-16-inch cold-rolled steel and a piece of ¼-inch drill rod.



It is used for drawing ratchet teeth or any similar work. If one has the time, a chuck or clamping device for holding a needle point might be made instead of the solid stem and point shown. The bevel, without this attachment, is quite handy in drawing as well as machine work. The device is not patented and some manufacturer might take a hint for the combination would be useful to any draftsman.

HANDYMAN.

PICKING UP SMALL ARTICLES WITH TWEEZERS.

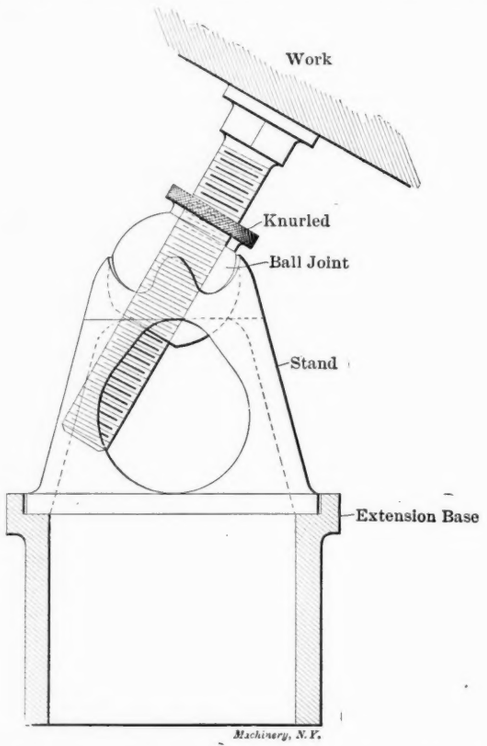
It often happens, in handling small pieces, such as screws and pivots, that the tweezers slip, because they have not a good grip. This may be got around by laying the object on the back of the hand—as being cleaner than the palm—and then picking it up. In this case the tool has a deeper grip on the object than where it must be picked up from the table or work-bench. If you don't believe it, try it.

It is singular, but I have never yet found a workman who had got on to this Columbus-egg-like trick.

Hannover, Germany. ROBERT GRIMSHAW.

JACKSCREW WITH EXTENSION BASE.

The sketch shows a convenient jackscrew which is easily adjusted to suit castings that are to be machined. The exten-

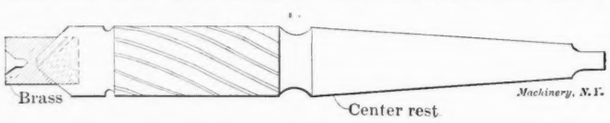


sion base shown can be built to suit the work, or two or three may be placed one on top of the other as the case may require.

I. N. QUIRE.

GRINDING A COMBINATION FLAT DRILL AND MILL.

Some time ago I made some special combination flat drills, and mills, for drilling and milling elongated slots in brass tubing. When the mills became dull, it was a serious problem to sharpen them and sharpen them concentric, as the original center, on the point of the drill, had been ground off, when the drills were ground. After everybody had had a



whack at the job without success, I came to the conclusion that the only way to grind them was to put a fake center on the point of the drill. This was done by taking a piece of brass and slotting the end part way, to straddle the flat of the drill, after which the mill and brass, were gently heated, and undiluted shellac applied. The mill is afterward recentered in the usual way, on the center rest. In grinding care must be taken not to hammer, or heat the mill as the brass plug is very easily separated therefrom. Shellac melts at about 190 deg. F., so there is no danger of drawing the temper of the tool. When the grinding is completed a slight tap on the brass plug separates it from the mill, which is then ready for use. FRANK G. STERLING.

Lowell, Mass.

TURRET KNURLING TOOL.

Fig. 1 shows a top view of a turret knurling tool complete and Fig. 2 a side view, while Figs. 3 and 4 are side and top details of the turret part, which is made of tool steel. Fig. 3 shows three sets of knurls, Nos. 1, 2 and 3, which are fine, medium and coarse, respectively. Each pair is made right and left-hand. They are mounted on ¼-inch Stubbs steel-hardened pins, *C*. In ordinary use the work rotates at *E*, E_1 or E_2, the selection of position being made for fine, medium

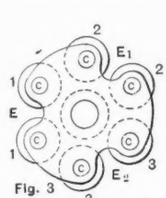


Fig. 3

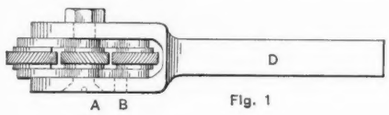


Fig. 1

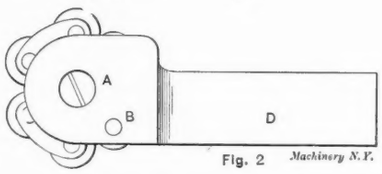


Fig. 2 *Machinery N.Y.*

Fig. 4

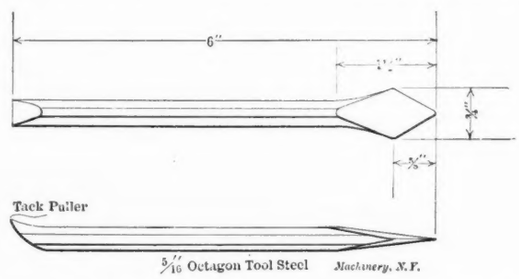
and coarse knurling as required. Where a simple spiral corrugation is wanted a single knurl may be used by locking the turret, and this is done by partly pushing out one of the pins *C* through the hole *B*, shown in Fig. 2, thus locking the turret in position so that a single knurl may be used. Ordinarily the turret carrying the knurls floats so that it automatically adjusts itself to the height of the rotating work. The turret part is mounted on a 5-16-inch countersunk hardened tool-steel screw, *A*, with nut.

C. C. ARRAS.

Buffalo, N. Y.

INK ERASER AND THUMB TACK PULLER.

I have read with interest the contributions telling how to remove ink from tracings, etc., and show sketch herewith of an ink scratcher which is in use in our drafting room. We use the scratcher to scrape off the heavy black lines, and then clean the rest off with a Faber's typewriter eraser, after which the erased surface is rubbed down with a soapstone pencil.



By doing this carefully the same place can be erased several times without cutting a hole in the tracing. It will be noted that the opposite end of the tool is formed into a claw for lifting tacks, thus making a convenient combination tool.

Torrington, Conn. E. C. FALK.

CASE HARDENING RING THREAD GAGES.

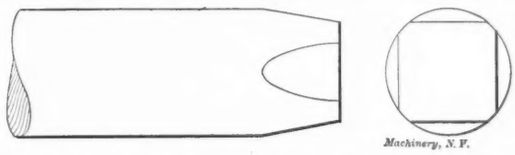
To harden ring thread gages without distortion anneal the gage after roughing out, and when finished cutting the thread, fill it with powdered cyanide and then heat up in a gas furnace, being very careful to exclude cold drafts as much as possible. When the heat has reached the right temperature turn the gas almost off and let the piece remain in the furnace for about ten minutes. Then dip in oil and keep moving around in a direction like the figure 8. When cool enough, remove and clean with kerosene oil. I have hardened many gages this way and the maximum change observed was only ¼ thousandth in a half inch.

EVERETT KNEEN.

Kearny, N. J.

THREADING OVERSIZE BOLTS WITH HAND DIES.

Here is a little kink that has saved me considerable hard work and strong language. I was working on a repair job a few years ago and had to thread a bolt with hand dies. As the iron was a trifle over-size and the dies were dull I had trouble in getting them to "take hold." I had begun to talk very plain to the bolt, the dies and the job in general when a friend asked me to let him show me how to start the dies on.



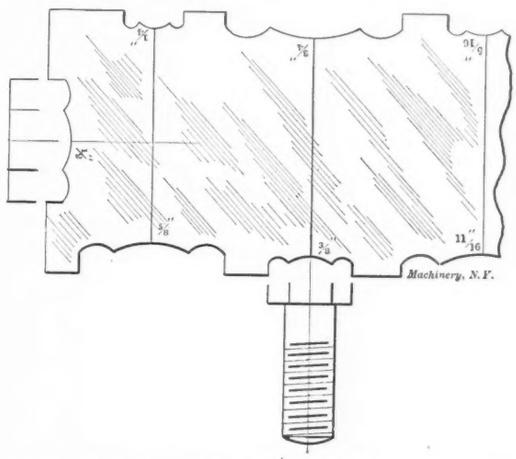
He took the bolt to the emery wheel and ground it so that it was nearly square on the end, as shown in the cut. The dies "took hold" without any further trouble.

I have since had occasion to use this kink a number of times and I trust it will save others considerable hard work.

Salem, O. ROY W. HARRIS.

TEMPLATE FOR DRAWING NUTS AND BOLT HEADS.

A very handy template for drawing nuts and bolt heads can be made as here shown. It is made of thin transparent celluloid and facilitates what is perhaps the most commonly repeated work to be done on a drawing. Lines are ruled on the template which, when used, are placed over the center



line on the drawing, and the curved outlines can then be drawn. The template can be made very readily by using the bow spring dividers which after repeated use will have cut into the celluloid enough to allow the pieces to be easily removed.

WINAMAC.

USING A METRIC TAPE AS A CIRCUMFERENCE RULE.

I accidentally discovered that the circumference tape, which gives the diameters in direct reading, has a rival in the metric tape. A centimeter is 0.3937 inch and $\frac{1}{8}\ \pi$ is 0.3927. Therefore, by measuring the circumference with a metric tape and reading the circumference in centimeters and converting same into eighths the diameter may be readily obtained in inches. For example, should the circumference measure 21 centimeters it is called 21 eighths, which equal 2⅝ inches, or the diameter. By this method of measuring diameters an error of 0.001 inch is involved for each centimeter but this is usually close enough for work measured by a tape line.

I sometimes use a millimeter scale for laying out diametral pitch distances, as, for example, 8-pitch equals 10 millimeters, 5-pitch equals 16 millimeters, and so on.

WINAMAC.

* * *

In the early manufacture of scroll chucks the teeth on the back of the jaws for engaging the scroll were first made by a series of plain milling cuts and the corners were afterward rounded by filing. Mr. A. F. Cushman, of Hartford, Conn., it is claimed, first devised the method of cutting the teeth in the jaws with a scroll cutter. This cutter was made of the same pitch and form as the scroll with which the teeth were to engage and was provided with milling teeth, which cut out the stock as the jaws were fed past it. This process saved all filing and made a great improvement in the manufacture of scroll chucks.

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

200. TO HARDEN DRILLS FOR CUTTING GLASS.

To harden drills for cutting glass, dissolve zinc in muriatic acid to saturation, then reduce the solution by adding an equal volume of water. Dip and use without tempering.

E. W. NORTON.

201. NON-RUSTING SOLDERING FLUID.

To prepare a soldering acid that will not rust iron, add to a saturated solution of zinc and hydrochloric acid ¼ part ammonia, and dilute the whole with an equal quantity of water. This has been very successfully used on knitting machines in soldering kneedles to their holders where an acid with the above characteristics is essential. J. H. V.

202. MIXTURE FOR CLEANING GRIMY HANDS.

A good mixture for cleaning grimy hands is made by pounding a cake of "Sapolio" or "Bon Ami" up quite fine, and stirring it into a cupful of pure leaf lard, heated very hot. Stir until well mixed and when it is partly cool pour into a tin or tins of convenient size to get the fingers into.

Worcester, Mass. M. E. HOWE.

203. TO REMOVE GREASE OR DIRT FROM MERCURY.

To cleanse mercury first put a ten per cent solution of nitric acid in an iron ladle, and then the mercury to be cleaned; place same over a blacksmith's forge until the nitric acid boils. The dirt will then rise to the top, and leave the mercury perfectly clean in the bottom. Care must be used not to let the mercury boil, as the fumes are very poisonous.

H. C.

204. A BELT CEMENT.

To make a reliable belt cement use 1 pound of Peter Cooper's white glue and 1 ounce of powdered white lead; mix like ordinary glue (thick). When used it should be thinned to the required consistency with grain alcohol and applied hot. This cement is particularly valuable where long hard usage is required such as for dynamo belts. J. H. V.

205. HARDENING FORMULA FOR CUTTING TOOLS.

To make a hardening solution for metal cutting tools mix saltpeter, 2 ounces; salamoniac, 2 ounces; alum, 2 ounces; salt, 1½ pound; and soft water, 3 gallons. Keep the solution in a stone jar for it will eat a wooden tub and rust an iron pot. Do not draw the temper but only warm the tools enough to relieve the hardening strains. It is also well to rinse the tools well in water, for if this is not done, the solution will rust them. TOOLMAKER.

206. TO CASE HARDEN CAST IRON.

I have successfully case hardened cast iron, using the following receipt: Pulverize and mix together equal weights of saltpetre, prussiate of potash and sal-ammoniac. Make a dipping solution by adding to each quart of cold water 1 ounce prussiate of potash and ½ ounce sal-ammoniac. Heat the cast iron pieces till redhot, roll them in the powder, and then plunge them into the liquid. J. M. MENEGUS.

Los Angeles, Cal.

207. TO SOLDER ALUMINUM.

The great disadvantage of aluminium to the sheet metal worker is the difficulty encountered in soldering. This is caused by the formation of an oxide on the surface of the heated metal, the oxide preventing the solder from alloying with the aluminium. This difficulty can be surmounted by employing the following method:

Make a solder of 80 per cent tin and 20 per cent zinc, and use stearic acid as a flux. Tin the surface wth the above, moving the copper bit backwards and forwards over the metal and flowing the solder. The film of oxide can then be cleaned off, and the coated surface can be easily soldered with the above named solder or ordinary tinsmiths' solder.

Manchester, Eng. A. EYLES.

208. TO IMPROVE THE COLOR OF SHELLAC VARNISH.

Occasionally the shellac varnish used by the pattern maker for varnishing very nice patterns will seem to lose its clear, amber tint. It is frequently the case that the jar is cleaned out and a fresh lot dissolved. This does not always cure the trouble. Any desired depth of tint may be readily obtained by the addition of a small quantity of gamboge previously dissolved in a small quantity of alcohol. It should be kept on hand for this purpose. OSCAR E. PERRIGO.

Neponset, Mass.

209. WIRE ROPE GREASE—GREASE FOR GEAR WHEELS.

A mixture of ¾ oil and ¼ colophony (rosin), will be found to be a very good lubricant for wire ropes such as used on power transmitting and conveying machinery, if applied warm. Boiled linseed oil also answers same purpose when high speed is required.

A good grease for gear wheels where iron meshes into iron can be made of 1 part of graphite, 4 parts of tallow mixed with some oil. For steel gears meshing into wood 1 part of graphite, 2 parts of beeswax and ½ to 1 part of tallow will form a very good and lasting grease for same.

Cleveland, O. MAX J. OCHES.

210. CEMENT FOR BELTS.

Mix 5 ounces bisulphite of carbon with ½ ounce spirits of turpentine, and enough gutta percha to make a paste. Thin the ends of the belt so that when they are joined the thickness at the joint is the same as the thickness of the belt. If the belt ends are greasy, apply some blotting paper and a hot iron to free them from grease. Then apply some of the paste, and press the parts together, using screw clamps and two pieces of board of the same width as the belt. The cement will dry in a short time, when the clamps can be removed. I have cemented belts in this way at night, and in the morning they were as nicely joined as could be wished.

Los Angeles, Cal. J. M. MENEGUS.

211. COPPER PLATING CAST IRON.

In the process of covering cast iron with a coating of copper the pieces of cast iron are first placed in a bath made of 50 parts of hydrochloric acid, specific gravity 1.1, and one part of nitric acid; they are next immersed in a second bath comprised of 10 parts nitric acid and 10 parts chloride of copper dissolved in 80 parts of hydrochloric acid, specific gravity 1.1. The pieces are then rubbed with a woolen cloth and immersed again until the desired thickness of copper is deposited. To give a bronze appearance the copper surface is rubbed with a mixture of 4 parts sal ammoniac and one part each of oxalic acid and acetic acid dissolved in 30 parts of water.

New Haven, Conn. A. L. MONRAD.

212. A GUN-METAL FINISH.

To make an imitation gun-metal finish by electrical process take ¾ pound of the double nickel salts to a gallon, and dissolve in boiling water. After the solution has cooled, add ammonia until it is slightly alkalized, then add sulphuret cyanide of potassium, about ½ ounce to a gallon. If a darker finish is required add more sulphuret. This will work excellently on all metals and they will come from the solution with a very high luster. If the work has been buffed and dipped before plating, it will require no further finishing, and should then be lacquered. It should be run with a very mild current from three to four minutes. J. L. LUCAS.

Bridgeport, Conn.

213. SOLUTION FOR BLUING BRASS.

A suitable solution for bluing brass is prepared by dissolving 1 ounce of antimony chloride in 20 ounces of water and adding 3 ounces of pure hydrochloric acid. Any amount of solution may be made up, provided the different ingredients are in the above proportion. To apply, place the warmed brass article into the solution until it has turned blue. Then remove it and wash with clean water, after which dry in sawdust. T. E. O'DONNELL.

Urbana, Ill.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

18. J. A. S.: What is the standard taper of thread for oil well casing?

A. ¾ inch per foot.

19. Inquirer:—In working out the design of a gas engine I had some trouble in finding its theoretical horsepower when using a mixture of one part illuminating gas to ten parts of air. As the problem stood I had a cylinder with 40 per cent clearance, which gave a compression of about 70.5 pounds per square inch. What will be the absolute temperature of compression and explosion and what the power of the engine using mixture given above? The engine has a ten-inch stroke and cylinder diameter of six inches and makes 300 revolutions a minute.

Answered by Dr. Sanford A. Moss.

No theoretical method is known for computing the power of a gas engine. Observation of existing engines using illuminating gas shows a "Mean Effective Pressure" of about 70 pounds per square inch for an engine of the size given, using a compression pressure of 70 pounds per square inch. This is for the best possible mixture of air and gas; that is, the mixture giving greatest power. The M. E. P. varies with size of engine, compression pressure, arrangement of combustion chamber, valve area, jackets, etc., so that a definite rule is not possible, and values obtained from observation of existing engines are the only ones possible. Using the familiar formula for engine power the brake horsepower is

$$e \times \frac{(M.E.P.)\, L\, a\, x}{33{,}000}$$

where e is the mechanical efficiency, or ratio of brake horsepower to indicated horsepower; L is the length of stroke in feet; a is the cylinder area in square inches; and x is the number of explosions per minute. In an average engine e has a value of 0.80. In a four-stroke cycle engine x is equal to $N/2$. The value of 70 for the M. E. P. is an average value for small engines using natural gas or illuminating gas. Using above values, the formula reduces to:

$$\text{Brake horsepower} = \frac{l\, d^2\, N}{18{,}000}$$

where l is length of stroke in inches, d diameter of cylinder in inches, and N revolutions per minute. A small four-cycle engine using natural gas or illuminating gas is supposed. The formula is only approximate.

The brake horsepower of a 6×10 four-cycle engine at 300 R. P. M. is about

$$\frac{10 \times 36 \times 300}{18{,}000} = 6 \text{ H. P.}$$

A mixture of one part of illuminating gas to ten parts of air is alluded to, and the absolute temperatures of compression and explosion are also referred to. These quantities are never known in any usual case, and can only be determined by most careful experiments and computations. The exact values of these quantities have no bearing on the practical problem of gas engine powering, and do not concern the gas engine designer in usual cases.

It is stated that a cylinder with 40 per cent clearance will give a compression pressure of 70.5 pounds. This compression pressure seems high, 50-pound gage being usually obtained with 40 per cent of clearance. About 30 per cent clearance is usually required to give 70 pounds gage.

20. C. B. H.: Please give a formula for finding the radius of a circular arc when the length of the arc and the height of its middle ordinate are given.

A.—We know of no method by which the radius of a circular arc can be calculated when only the length of the arc and the height of its middle ordinate are known, although there is one for the converse, as when the length of the arc is required, having given the radius and the height of the middle ordinate. The following approximate formula for solving this is given in Haswell's handbook.

$$L = \frac{2c \times 10 \text{ versin}}{120r - 27 \text{ versin}} + c$$

in which

L = length of arc,

c = chord of half arc,

versin = height of middle ordinate,

r = radius.

The chord of half the arc is found by the formula

$$c = \sqrt{\tfrac{1}{2} C^2 + \text{versin}^2}$$

in which

c = chord of the half arc,

C = chord of the arc.

You will find tables in most engineer's handbooks giving the lengths of circular arcs and the equivalent height of the middle ordinate by small divisions up to a semi-circle.

* * *

An exceedingly interesting story is told by Mr. H. S. Cooper, manager of the Galveston Electric Co., in the May 12, 1906, issue of the *Street Railway Journal*, of the great difficulties imposed on the operation of his company by the raising of the grade of the city of Galveston. As all of our readers probably remember, Galveston was wrecked by a great ocean storm which flooded the city several years ago, and to prevent a repetition of this disaster the engineers decided to raise the grade level of about half the city, the fill varying from a few inches up to 9 or 10 feet. The method employed to convey the many millions of cubic yards of earth required was to pump a mixture of sand and water from the ocean bed through 42-inch pipes which were connected to great dredges outside the sea wall. In this way in a day of 24 hours there were often delivered from 12,500 to 15,000 cubic yards of sand, or the equivalent of, say, 1,000 railroad car loads. But, inasmuch as only from 25 to 33 1-3 per cent of the mixture pumped was sand, it represented a volume three or four times as great. The great volume of water which had to flow away made the difficulties of the street railway company simply enormous. Their tracks had to be raised during each flooding operation; at the beginning this consisted of clear salt water and the same at the end of each pumping period, this being necessary to prevent clogging of the pipes which would have resulted had the sand been left in them when pumping ceased. The flow of clear water would wash away the sand to begin with and then as the sand and water came the sand would be rapidly deposited on the tracks. The men would have to work with their feet sunk in a mixture of quicksand so deep that it was with difficulty that they could change their positions. Then, at the end of a pumping period, came the flow of water again, which would often wash away the sand from between the ties and cause them to settle from a few inches to several feet. During all this time the cars were kept running over a track whose sinuosity would rival that of a worm rail fence, both in lateral and vertical directions. The rusting caused by the salt water played havoc with the bonding of the rails and with the bearings of the cars. In fact it is hard to conceive of anything worse for machinery than a mixture of salt water and sharp sea sand. As the level of the tracks was raised, it was necessary to raise the poles carrying the feed wires, and this alone was a job of no small difficulty. The sand while wet was a quicksand which would flow almost like water, and it resisted the raising of the poles with enormous frictional resistance as well as an atmospheric pressure of practically 15 pounds per square inch. The yielding character of the surface sand made the use of improved mechanical devices for pulling the poles upward of practically no avail and the work was reduced to the use of 30-foot wooden levers working over "bait" supported on planks and with twelve strong men at the business end of the levers. Altogether it would appear, from the manager's entertaining description, that the Galveston Electric Co. successfully met difficulties of operation that were never equalled in the history of any other electric street railway company.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

A PULLEY CROWNING DEVICE.

The American Tool Works Co., Cincinnati, Ohio, have recently built an interesting pulley crowning device which is shown in the halftone, Fig. 1. The sectional view, Fig. 2, will perhaps make its operation a little clearer. The parts shown in the line cut may be readily picked out in the half-

Fig. 1. Pulley Crowning Attachment.

tone. The basis of the device is the taper attachment furnished with the lathes built by this concern. The cross-feed screw *F* rotates freely in block *G*, but is held in position by it longitudinally. It may be rotated by the handle on shaft *K*, which is provided with a hole into which the screw *F* telescopes; it is driven from *K* by the key as shown. In the regular attachment the nut is attached to the cross slide *E* by the screw as shown, which, however, passes through a slot in the cross slide. When the taper attachment is in use this screw is loosened, thus permitting the guide bar to move the slide in and out without reference to the cross slide screw. As arranged for the pulley crowning device, however, the nut is permanently fixed to the slide.

On the supplementary way *C* at the rear of the machine is fastened the former, *B*, which has a groove machined in its upper surface on an arc corresponding to the radius of contour it is desired to give to the pulley which is to be crowned. In this groove slides the block *A* which is engaged, through a pivot center and clamp *D*, with the slotted extension *E* of the cross slide. It is thus readily apparent that with former *B*, located in position on the way *C* by clamp *J*, slide *E* will be given an in-and-out motion which will reproduce at the tool point the contour of the groove in former *B*. The fact that cross-slide screw *F* telescopes in *K* allows it to move in and out freely with the slide. To allow block *G*, however, to move longitudinally, the upright lever shown at the left in Fig. 1 must be thrown over. This action withdraws a fork from the slots in *G*, thus freeing it. When it is desired to use the lathe in the ordinary run of work this fork is again thrown in engagement with *G*, locking it in position and again giving the cross-slide screw control of the cross slide, after handle *D* has been loosened from its engagement with the slotted end of *E*.

To make provision for centering the curve of the pulley, a locating pin is provided at *H*. This passes down through the center of the pivot of block *A*. In the center of the arc in block *B* is a hole to receive the lower end of this pin. When knob *H* is pressed down and the pin inserted in this hole, clamp *J* may be loosened so that *B* slides freely on *C*. If then the carriage be moved until the tool point is exactly half way across the face of the pulley, handle *J* may then be tightened, pin *H* withdrawn, and the attachment will be centered so that the largest diameter of the pulley will be in the center of the face.

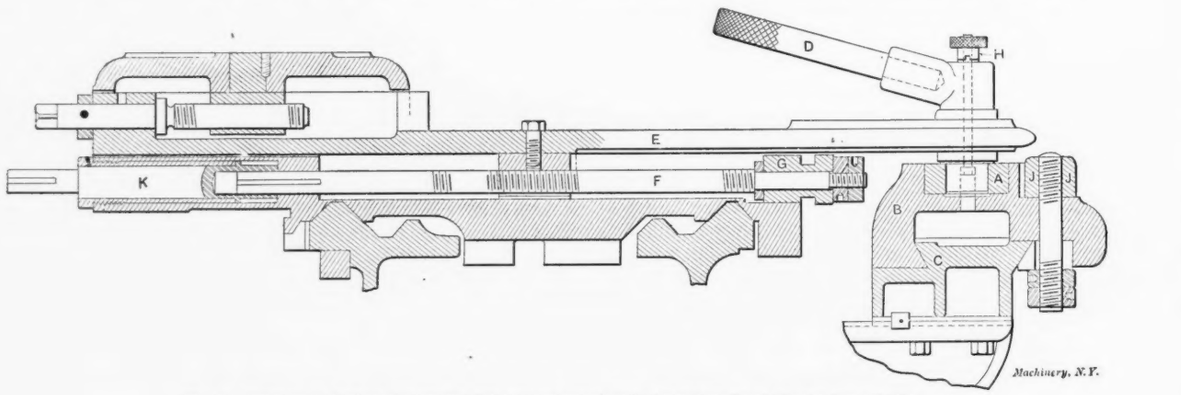
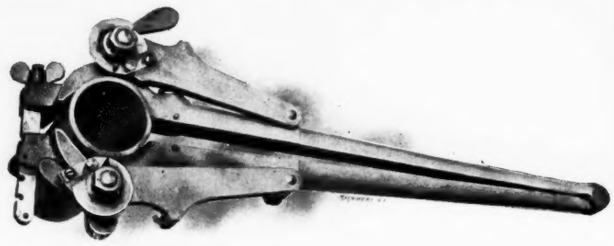


Fig. 2. Section of Pulley Crowning Attachment used with American Tool Works Co.'s Lathe.

VOSPER PIPE CUTTING TOOL.

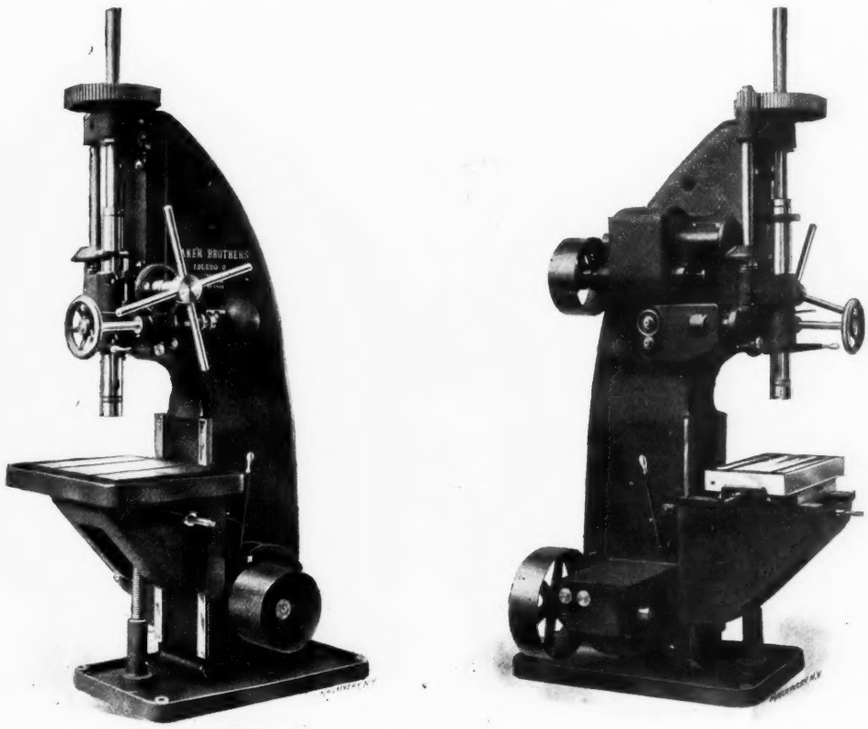
W. W. Vosper, 611 Osborne Street, Sandusky, Ohio, has invented and is manufacturing a pipe cutter, the principle of which will be readily understood from the following description and cut. As may be seen, the frame of the apparatus consists of a pair of hinged arms somewhat like old-fashioned fireplace tongs in their arrangement, but provided at the outer end with wide V surfaces for grasping the pipe. The thumb nut shown, acting on the threaded tie-bar, draws the V's together to suit the size of pipe being cut. The tie-bar has notches formed in its outer side which engage with a pin in the lower lug; when the bar is thrown out at an angle of 45 degrees it may be readily changed from one notch to another to suit different diameters of work. The tool shown will handle pipe from 2½ to 4 inches in diameter.



Pipe Cutting Tool.

The cutters are formed out of round disks about 0.05 inch thick. They are supported on supplementary arms hinged to the main frame of the device, and are drawn in by the constant tension of a pair of powerful springs, which are not very well shown in the illustration. The tension of these springs is more than enough to feed the cutter when the device is revolved. To prevent the taking of too heavy a chip,

in front of each cutting edge is fastened a shoe which rides on the work. The point of the cutter is just enough deeper than the point of the shoe to give a reasonably heavy cut. The thickness of the chip is thus a constant quantity no matter whether the pipe be round or of a distorted shape. To throw the tool out of action cams are provided, operated by the handles shown, which may be used to lift the arm away from the work and lock the tool in the outward position. The cutting edge of the blade is not square across, as is the usual case in pipe cutting tools. One of the cutters is beveled in one direction while the other is beveled the other way. This divides the chip, each of the tools cutting only half the full width, thus preventing the tendency to dig in and catch which is always present with a tool cutting the full width.



Baker High-speed Drill.

DRILL PRESS FOR USE WITH HIGH-SPEED STEEL.

Baker Bros., Toledo, Ohio, have designed a drilling machine, of which we show two halftone cuts above. This machine is arranged and proportioned to be especially suited to the requirement of driving ½-inch to 1½-inch drills made of high speed steel. The advantage which this type of frame possesses over the usual light design is in the avoidance of distortion under the pressure of a heavy feed with a large drill. If the main casting of the machine springs under the pressure of a cut, the drill will bind in the hole, especially if it be a long one; this results in a material increase in the amount of power required, which may be in extreme cases two or three times that required for removing the metal; this extra power is converted into heat which still further expands the drill, causing it to bind still more tightly; and finally the drill, when so cramped, is very liable to break. The design of the frame of this tool obviates all danger from these sources.

As may be seen in the cut, the machine is driven from a constant speed belt, direct from the line shaft, running onto tight and loose pulleys at the base of the column on the right hand side of the machine. From here the motion is transmitted through enclosed back gears to the intermediate pulley on the left hand side of the machine where connection is made by belt with the speed box at the upper end of the column. The change of speed here is made positively as is the case in the lower gearing, there being no ratchet or friction drives in the machine.

This drive gives the machine eight speeds, varying from 25 revolutions per minute to 370 revolutions per minute, thus covering the requirements for a tool to use either carbon or high speed steel drills, and adapting it to boring operations as well. The intermediate belt is liberally proportioned and will not slip under the most severe service, yet it will act as a safety device in the case of accidents. From the upper speed box the action of the driving mechanism may be easily traced through to the spindle. A positive feed is used which may be quickly changed, giving any one of three variations with a provision for compounding.

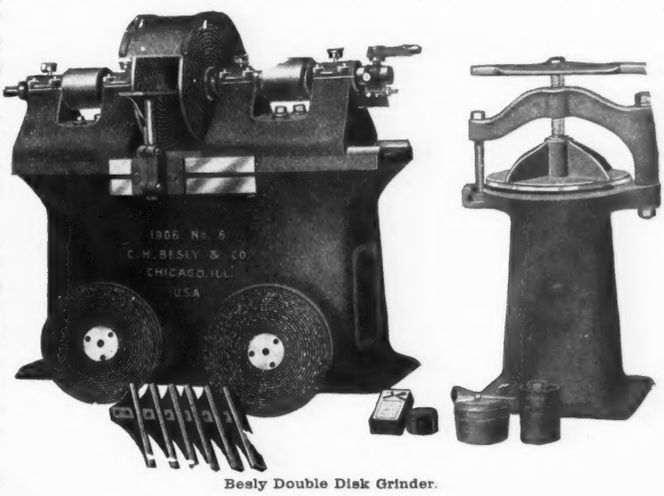
The table is gibbed securely to the front of the machine and is further supported by the elevating screw, which is heavy and capable of taking the entire thrust of the cut. The elevating screw works on ball bearings so that the table may be easily raised and lowered even though heavily loaded. A compound platen may be used, allowing the work to be quickly and accurately centered under the drill after it has been clamped to the table; when so centered the table does not have to be locked in place, but will stay wherever set. While one piece is being drilled another may be chucked on the opposite end of the table.

The bearings are all bronze bushings and the shafts are all ground. The back gears and speed change gears run in oil. It has been the intention of the makers to forestall any criticism on the score of either design or workmanship, and the questions of rigidity, driving power at high speeds, ease of manipulation, smoothness of running, wide range and durability have been the determining features of the design.

The spindle travel is 16 inches. The spindle is bored to fit a No. 4 Morse taper shank. The plain type of table is 17x23 inches inside the oil groove, while the compound style, like that shown in the right-hand cut, is 13x20 inches with a travel of 10x18 inches. The spindle will drill to the center of a 24-inch circle. The weight of the tool is about 3,000 pounds. Alternative arrangements may be specified, such as oil pump attachment, motor drive, etc. Provisions for these have been made in the original design.

BESLY DOUBLE DISK GRINDER.

The accompanying halftone shows a tool which its builders, Chas. H. Besly & Co., Chicago, Ill., have recently designed to perform certain operations constantly met with by users



Besly Double Disk Grinder.

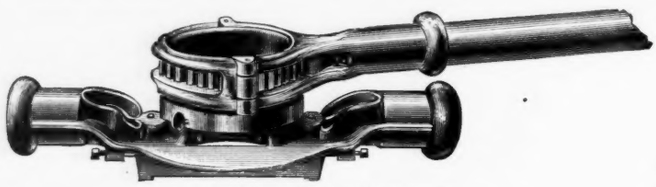
of disk grinders. As may be seen, the machine consists of two grinding disks of the usual type built by the makers, which are mounted in heads adjustable to or away from each other along ways on top of the column. Between these two disks is the table which supports the work, which may thus have two sides finished at the same time parallel to each other and perpendicular to the base on which it is supported.

To insure accuracy it is necessary that the spindles be parallel to each other and at right angles to the work table. With this end in view the heads are supported and guided on top of the column in the same way as is followed in engine lathe practice, V's being provided onto which the heads are clamped by the bolts shown in the cut. The spindle bearings, in accordance with the experience of the makers, are of cast iron lubricated with solid oil supplied by oil cups especially designed for the purpose. The end motion of the disks is controlled by adjustable keyed collars held in place by lock nuts at the ends of the spindles. The end thrust is taken on hardened and ground collars of large area. The in and out movement of the movable head is about one inch and special care has been taken to reduce the amount of sliding surface to a minimum.. This surface is entirely enclosed in the bearing bushings, which slide with the spindle. This arrangement not only protects the bearing surface from dust, but insures that the disk wheel on the sliding spindle is always near to, and rigidly supported by the main head casting. The sliding spindle is brought up to the work by means of a pinion on the lever shaft, actuating a rack on the bushing at the rear bearing; this rack and pinion mesh vertically so that emery dust does not tend to lodge and wear the surface.

The work rest bracket is rigidly supported and the T-slot in the front of the bed and the V's on its upper surface make the machine readily adaptable for holding any special apparatus which may be required. Either or both heads may be removed at a moment's notice. The machine is equipped with 20-inch disks and weighs about 3,500 pounds, together with the countershaft, floor press and accessories. The bed casting has a 5½-inch opening for attaching an exhaust pipe to carry away the dust from the grinding operations.

A RATCHET ATTACHMENT FOR DIE STOCKS.

When threading pipe in confined quarters, in a ditch, for instance, or close in the corner of a room, it is generally impossible to use the ordinary two-handled stock, and one operating with a single handle on the ratchet principle becomes necessary. A number of these are on the market, most of which require that the buyer should purchase a complete stock in order to avail himself of the ratchet.



Armstrong Ratchet Attachment.

The Armstrong Manufacturing Co. of 297 Knowlton St., Bridgeport, Conn., are making the device shown in the cut which can be attached to one of their regular die stocks by the simple tightening of a thumb screw. In using this attachment the double handles are removed from the tool, one of them being screwed into the sleeve of the attachment where it is used to turn the dies. The parts are made of light but strong malleable iron castings. The pawl may be instantly adjusted for turning the die in either direction.

DAYTON CUTTER GRINDER.

The Dayton Machine Tool Co., Dayton, Ohio, are building a universal grinder, which is shown in the cuts working at about the extremes of its capacity in both directions. Fig. 1 illustrates the sharpening of a 12-inch cutter which is used to mill slots 1½-inch wide by ¾-inch deep in steel bars. The sides of the cutter as well as the front are ground with straight line clearance. This machine will take similar cutters up to 18 inches in diameter by 4 inches deep without extra fixtures other than the arbor on which the tool is supported. The second illustration shows the grinding of the end teeth of a T-slot cutter, using a cup wheel for this operation which is mounted on the internal grinding attachment spindle, thus giving the requisite speed and permitting the use of a wheel small enough to grind the smallest end mill.

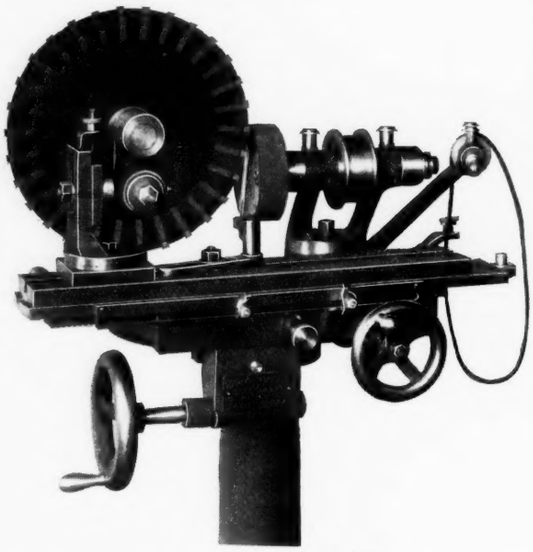


Fig. 1. Driving a 12-inch Mill.

On this job an index dial is used for spacing; this does away with the annoyance of using a tool rest on a small cutter. The internal spindle attachment can be set at any angle with the table, not being confined to any position, since it swivels with the wheel base and is practically an integral part of it. The

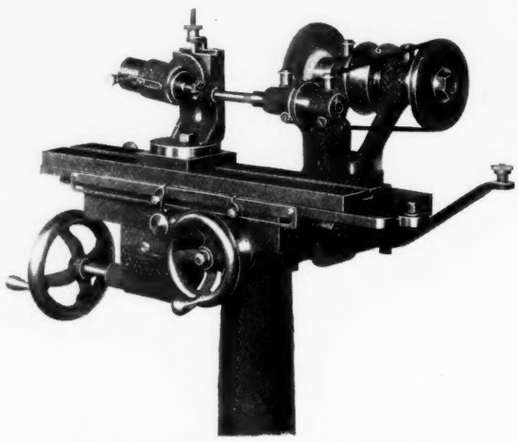


Fig. 2. Sharpening the Face of a T-slot Cutter.

main emery wheel spindle may be, of course, swiveled in a similar manner through an arc of 180 degrees, and may be locked in any required position. The makers will cheerfully furnish any one interested any further information that may be desired.

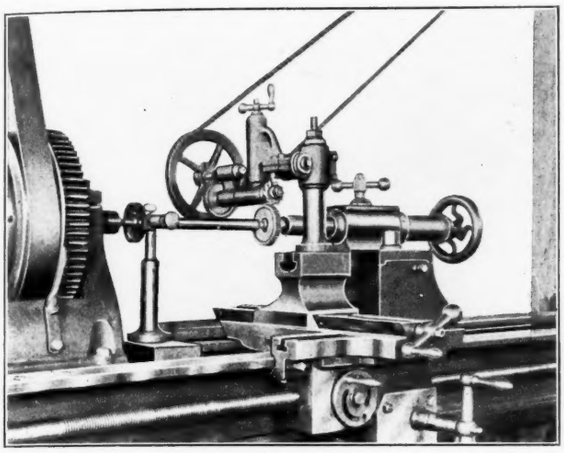
LATHE MILLING ATTACHMENT.

The accompanying halftone shows a device which may be used in connection with an engine lathe to perform a variety of milling operations. The cut shows the milling attachment fastened to the tool post of a lathe and engaged in the operation of cutting a gear blank which is secured to an arbor and mounted between centers. At the other end of the arbor is a lathe change gear which is being used as an index plate in spacing the blank. The cutter is driven independently from the line shaft, or from any other suitable source of power, by a right angled drive provided with an automatic take-up to allow the carriage to be moved to any position on the lathe shears. The depth of the cut is adjustable by the ball crank and screw shown, while the cross slide of the lathe allows the cutter to be set at any distance from the center of the machine that may be desired. The feed of the

lathe is used for feeding the cutter. The builders of this device, the Brickner Machine Co., 7 South Washington Street, Tiffin, Ohio, claim that it will do the work of an ordinary milling machine at one-sixth of the first cost.

THE PRENTICE HIGH-SPEED TURRET LATHE.

Prentice Bros. Co., Worcester, Mass., have developed a turret mechanism for their new high speed lathes which especially adapts them to the machining of castings. The turret, which is of hexagon shape and of large size, is mounted on the cross slide of the carriage, as shown in Figs. 1 and 3. Fig. 4 shows the design of the turret and the arrangement of the stops by which its motions are controlled. The diameter of the holes in the turret is 2¼ inches, and a space of 5 inches by 6 inches is available for attaching tool holders of various shape. It has a flat annular base and may be clamped to the slide by a stud passing through its center in the usual manner. The locking pin, *B*, Fig. 4, operated by the handle shown at the front of the slide in Fig. 1, is seated in a hardened bushing contained in a rim integral with the turret and projecting downward into a corresponding groove in the top of the slide. The lower edge of the downwardly projecting rim has teeth cut in it to form a large bevel gear, which meshes with the small pinion, *C*, keyed to the shaft, *D*, but is free to slide in or out thereon, according to the position of the cross slide. Shaft *D*, through a train of bevel and spur gears which may be readily traced, is connected with shaft *E*,



Lathe Milling Attachment.

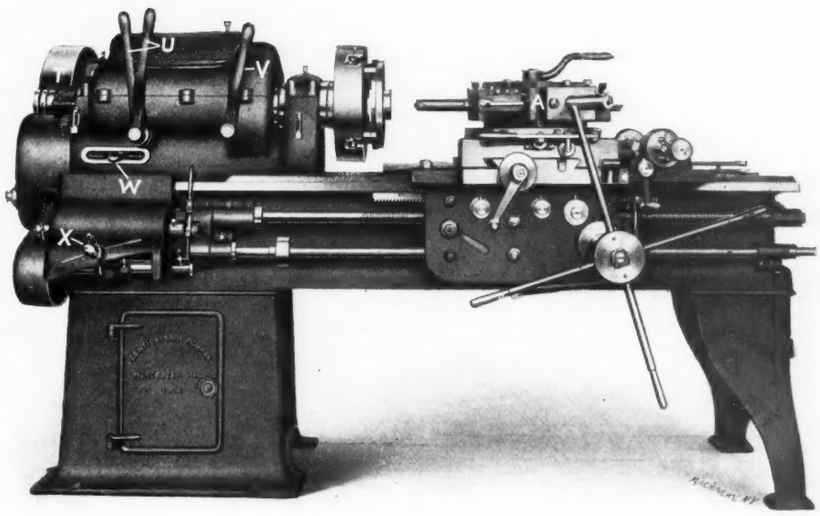


Fig. 1. Prentice High-speed Turret Lathe.

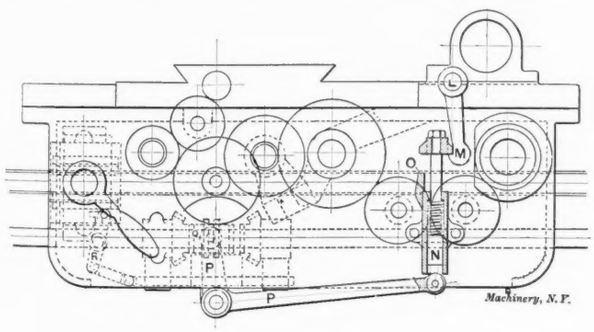


Fig. 2. Apron of Prentice High-speed Turret Lathe.

on which is mounted drum *F* carrying a series of 6 adjustable stop screws, one for each hole in the turret. The speed ratio of this train of gearing is such that for every 1/6th revolution of the turret the stop drum will rotate 1 1/6 revolution, thus always presenting a definite stop for each face of the turret. In case it is desired to use two stops for one station, collar *G* may be moved back until the pin which connects it with drum *F* is withdrawn from engagement. Any stop screw desired may then be presented for action but when collar *G* is thrown in again, the drum will be returned to its former position since it is provided with but one hole for the connecting pin. The stops abut against the dog, *H*, which may be clamped in any position desired longitudinally in the T-slot furnished for it between the ways of the lathe bed.

When the end of a stop screw and the face of the dog have come in contact the drum *F* and shaft *E* are arrested in their movement, and continued feeding of the carriage compresses the spring at *J* until the bushing at this point is clamped between the washer on the shaft and the main casting of the slide, when the carriage comes to a dead stop. Before this positive stop comes into action a throwout is operated which disengages the power feed. The spool *K*, which is pinned to shaft *E*, is connected with the rock shaft *L* in Fig. 2. When the forward motion of shaft *E* is arrested by contact of the stop screw with dog *H* the continued feeding of the slide rocks shaft *L* slightly, thus throwing the lower end of level *M* to the right and releasing the catch on the upper end of flange *N*, which is thus allowed to drop under the pressure of the spring shown until it comes in contact with projection *O*, which action, through the medium of the bell crank *P* throws out the clutch *Q*, which plays between the two bevel gears on the feed rod, and thus disengages the feed. The parts are so arranged that this release of the power feed takes place just before the positive stop comes into action, thus leaving a few thousandths for the workman to feed with the pilot wheel. This gives a better and more accurate finish to the shoulder than could be obtained by an absolutely automatic stop.

When it is desired to reverse the feed of the carriage or the cross slide, both of which are controlled by lever *P*, and the clutches and bevel gears at *W*, the catch on the upper end of plunger *N*, which is provided with a handle as may be seen in Fig. 1, is revolved until it no longer is engaged by projection *O*. The spring then forces the plunger to the bottom of its travel and the feed is driven through the bevel gear at the right of *Q*. Besides the splined feed rod a screw is provided which is used for thread cutting and for heavy feeding. An interlocking lever, *R*, is provided which moves in unison with bell crank *P* and is provided with a pin engaging in a slot in the split nut which engages the screw. This arrangement, as will be readily understood by an examination of the drawing, makes it impossible to engage the screw feed and the rod feed at the same time.

On the rear of the carriage are the cross slide stops, of which there are one on each side for each station of the turret.

These stops are revolved by hand and abut against adjustable dogs at the side of the cross slide; they automatically stop the friction cross feed at any point desired on either side of the center line. The cross feed is 7½ inches. The combination of cross and longitudinal stops and the large clamping surface provided for the tools on the turret, adapt this machine to the economical handling of both simple and complex work.

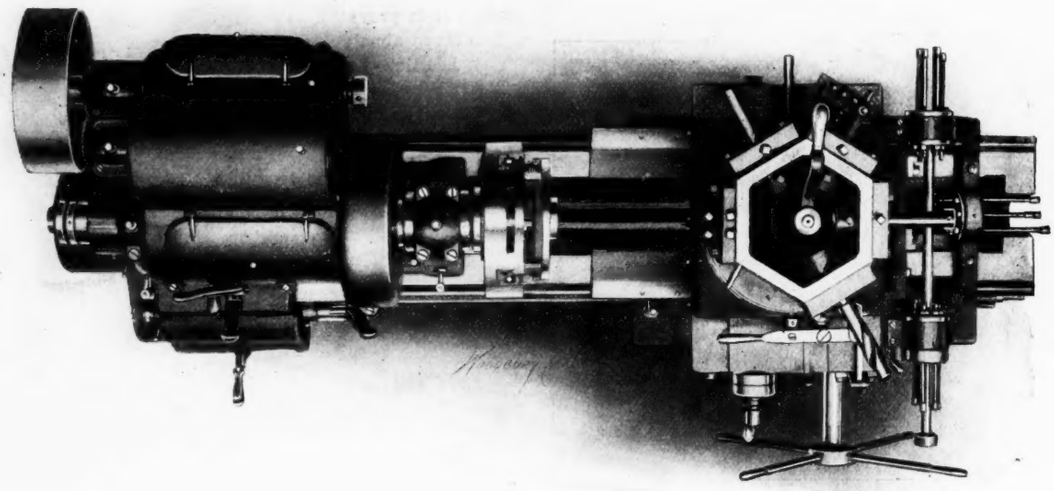


Fig. 3. View Looking Down on Prentice High-speed Turret Lathe.

The head stock mechanism is the same as that provided with their high speed engine lathe. It is driven by a 4-inch belt on a constant speed pulley 14 inches in diameter at *T*, and eight changes may be obtained in the head stock by operating the friction clutch levers, *U*, and the back gear lever, *V*. If a double speed countershaft is used this number of speeds may be multiplied by two. A wide range of speeds is of course necessary for a machine of this type where facing cuts on castings of large diameter are of constant occurrence. An all-geared feed is provided. Four changes may be obtained by handle *W*, and eleven by lever *X*, thus giving forty-four feeds in all.

MULTIPLE-SPINDLE DRILL.

The National Separator & Machine Co., Concord, N. H., build the upright drill press shown in the halftone. The machine is designed for drilling, tapping, reaming, etc., on duplicate parts without necessitating the changing of the tool or the work. As shown, it is provided with four spindles, but as many as six may be provided if the work on which it is to be used requires it. The construction will be evident from an examination of the cut. The drive is similar to that of the usual form of drill press so far as the use of the cone pulleys and the upper horizontal shaft driving the spindle through bevel gears, is concerned. The spindles, four or six as the case may be, are mounted in a skeleton drum which is revolvable about a vertical axis in a casing clamped to the column. Each spindle as it is brought into place is connected by a gear at its upper bearing with either one of the two driving gears on the vertical driving shaft. This allows a choice of speeds for the different tools. The feed is handled either by the pilot wheel, the hand wheel, or by power through the feed cones driven by the upright shaft. The locking mechanism is close to the spindle in use, so that the construction is very rigid. Each spindle has an independent stop.

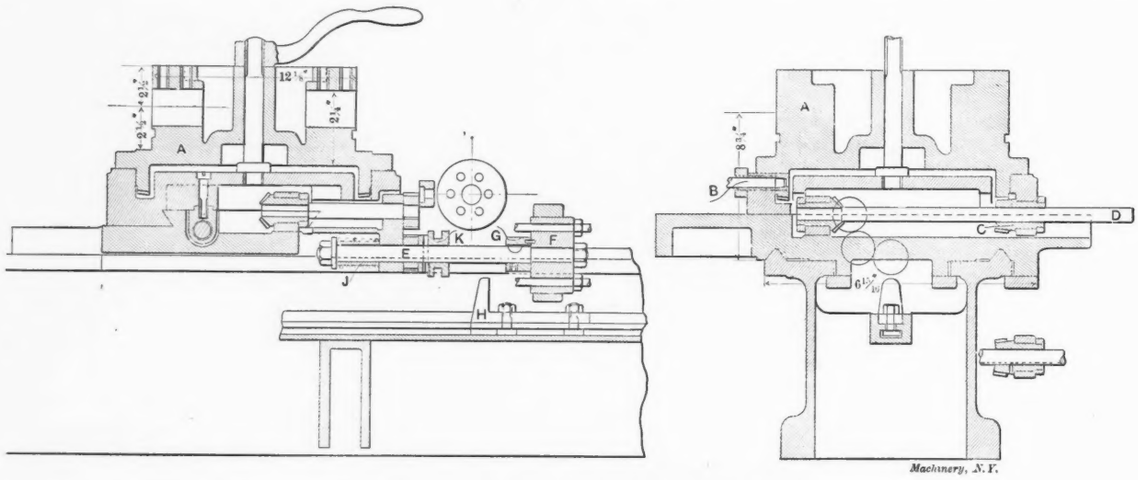
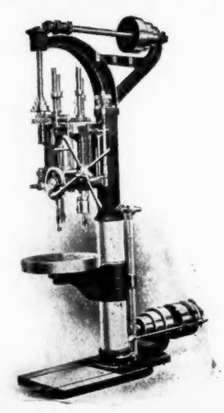


Fig. 4. Construction of Turret, Prentice High-speed Lathe.

* * *

The full load deflection of structural beams should, in general, be limited to about 0.0025 of the span; that is, if the span be 20 feet, the deflection in the center under full load should not exceed 0.6 inch, or at most ⅝ inch. Beams may be cambered so that greater deflection may be allowed without causing noticeable sagging of ceilings, etc., but this practice is not to be recommended.

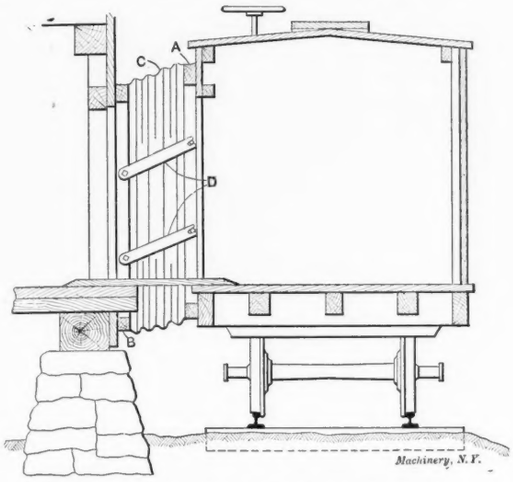


National Multiple-spindle Drill.

ITEMS OF MECHANICAL INTEREST.

A PULLMAN VESTIBULE FOR THE SHIPPING ROOM.

In the dead of winter when the thermometer is away down and the wind velocity is away up, the opening of a door in the shipping or receiving department for the purpose of transferring freight between the building and a box car has the effect of cooling the room to such an extent as to make it a very uncomfortable place to work in. To overcome this difficulty, the R. K. Le Blond Machine Tool Co., of Cincinnati, use



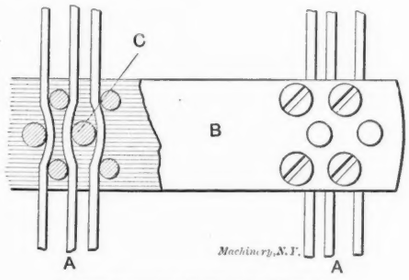
Keeping the Cold Air out of the Shipping Room.

a little vestibule arrangement which makes an enclosed passage way between the shop and the car. A sketch of this is shown herewith.

A light rectangular frame work *B* surrounding the shipping door is fastened to the outer wall. A similar framework, *A*, is connected to this by two swinging arms, *D*, on each side, and between these two frames is fastened the tube *C* of heavy close woven duck, or some other similar material. When the box car is in place, as shown by the sketch, it will be readily seen that the weight of the outer frame work, *A*, acting on the arms *D*, tends to hold it firmly against the side of the car, thus forming an enclosed passage way between it and the building tight enough to prevent the wind from entering to any great extent. When this arrangement is not in place it may be folded up against the side of the building, bellows-fashion. The device is so effectual that one can almost walk into the car, if he be a stranger, without realizing what sort of a place he has gotten into.

SHOCK ABSORBER.

The matter of stopping a rapidly falling body, such as a loose elevator car without severe shock to the occupants is not easy, although numerous inventors have tackled the problem with great confidence. Some of the so-called safety



Safety Stopping Device for Elevators.

devices for elevator cars are nearly as bad as nothing at all, for when the cable snaps they do not act immediately, but allow the car to fall several feet before the clamps grip the elevator guides. Then they take hold so suddenly that the car is stopped at once with more or less disastrous effects on the car and its freight. A device which absorbs the shock of the falling car smoothly is shown in the accompanying sketch, because of the ingenious but simple principle used. This device, unfortunately, was backed by certain parties in such a way as to give it an unsavory reputation, and it has never come into common use. It is illustrated merely to show a principle that may be useful in other directions where a uniform and reliable stopping effect is required and in which the surface conditions will not affect the stopping action materially. As shown in the cut a number of parallel wires, *A*, are strung, and on these are mounted at intervals clamps, *B*, in which are located a number of screws or pins so placed that the wire is kinked slightly between the adjacent pins. Now, it is obvious that any displacement of *B* will produce successive bending of the wires, the resistance depending on how much the kinking or bending is. The surface condition of the wire will make little difference in the resistance, as the greater part of it is due to internal and not surface friction. In use as an elevator device, a number of such clamps are provided one, at least, for each floor, and movable hooks or dogs are so worked that when a car falls they must engage these clamps and drag them down with the car. If one set of clamps is not sufficient to break the fall it would very soon come in contact with another set and so on, the velocity being gradually lessened until it comes to a full stop.

SPRING-NUT FOR CHANGE GEARS.

The accompanying cuts, Figs. 1 and 2, show end, side and section of an interesting and convenient device for facilitating the shifting of change gears on screw-cutting engine lathes. It is a feature of the "Star" lathes made by the Seneca Falls Mfg. Co., Seneca Falls, N. Y., and is an extension of the well-known slip collar idea which, in connection with a bore in the change gears larger than the nut makes unneces-

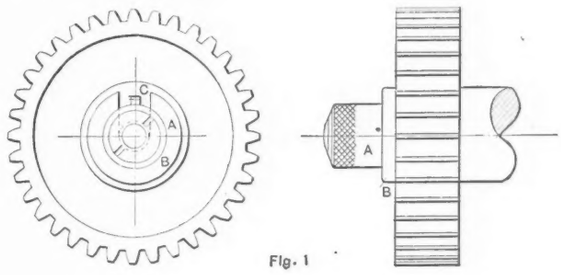


Fig. 1

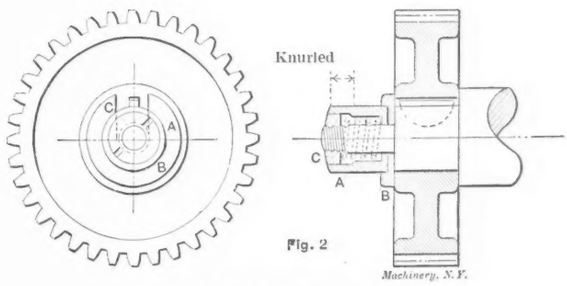


Fig. 2

Spring Nut for Change Gears.

sary the removal of the nut when changing gears. With this familiar device as we all know the loosening of the nut allows the collar to be slipped off laterally and then the gear is pulled off over the nut. The device here illustrated goes this arrangement one better for it makes the use of a wrench unnecessary, the knurled piece, *A*, being merely pulled out longitudinally far enough to disengage it from the annular recess turned in the face of the coller *B* so that the latter can be slipped off sideways and then the gear is pulled from the stud. The cut illustrates the construction clearly; it shows that the spring is retained in place by the nut, *C*, which is slotted for a pronged screwdriver, but inasmuch as this part never has to be disturbed the use of tools is entirely unnecessary in the ordinary working of the device.

* * *

Don't plane a heavy chip off from a casting, without chipping or filing the back corner off to a bevel as far down as the tool goes; this avoids breaking out.

OBITUARY.

Charles C. Newton, president and treasurer of the Newton Machine Tool Works, Inc., Philadelphia, Pa., died at Bremen, Germany, on June 13. Mr. Newton had not been in good health and went abroad to seek relief at the baths at Bad, Nauheim, Germany, but was too ill to continue his travel after his arrival at Bremen.

Mr. Newton held an enviable position in the business and engineering world through his ability as a designer of machine tools and the success of the firm of which he was the founder. His designs have been characterized by originality and he was a pioneer in the development of cold sawing machines for metal and later on, portable floor plate machines now used so extensively in heavy machine work.

Charles C. Newton.

He was born at Cambridge, N. Y., in 1846. At nineteen he indentured himself as apprentice to the Brooks Locomotive Works, Dunkirk, N. Y., spending most of his time in the tool room. After serving his apprenticeship and working in various shops, Mr. Newton returned to Dunkirk in 1875, and in partnership with J. D. Cox manufactured twist drills, reamers, cutters, etc. In 1876 the firm moved to Cleveland, O., operating under the firm name of Newton & Cox. In 1880 Mr. Newton sold out his interest to Mr. Cox, who formed out of the old firm the Cleveland Twist Drill Co.

Removing to Philadelphia, Mr. Newton laid the foundation for the present Newton Machine Tool Works, Inc., in a little shop at 2341 and 2343 Callowhill Street, with only himself and an assistant as the working force. In this shop he designed the first heavy railroad tools, and as the demand grew for his various designs, he was forced to seek larger quarters. In the fall of 1886 he built a new shop at the corner of 24th and Wood streets and there designed the first successful machines for sawing metal cold, and also a large number of new tools, for which he took out patents. As this shop soon became too small, Mr. Newton built in August, 1895, the first part of the present shop on the corner of 24th and Vine streets, which he has since increased to take in the entire square bounded by 23d, 24th, Vine and Wood streets.

Mr. Newton was the sole proprietor of the works until July 14, 1897, when articles of incorporation were taken out, not with a view of increasing the capital, but as a business move, and the firm became the Newton Machine Tool Works Inc., with Mr. Newton as president and treasurer.

Mr. Newton was a member of the Engineers' Club, American Society of Mechanical Engineers, the Art Club of Philadelphia, and the Athletic Club of Philadelphia.

* * *

PERSONAL.

F. W. Aurig was recently made superintendent of the Eastern Auto Co., Philadelphia, Pa.

Fred P. Gates, of the Mergenthaler Co., of Brooklyn, N. Y., has taken a position as superintendent of the Bantam Anti-Friction Co., Bantam, Conn.

J. H. Gill has resigned his position with the Millikin University, Decatur, Ill., to take charge of the department of machine construction at the University of Illinois.

Carroll Ashley, the author of "Practical Planer Kinks" and a contributor to MACHINERY and other mechanical papers, is now with the Ritter Dental Mfg. Co., Rochester, N. Y., as foreman of the toolroom in their chair department.

A. L. Monrad, who has been with the Winchester Repeating Arms Co., New Haven, Conn., in the model and gage department for the last eleven years, has resigned to accept a position as superintendent with the H. A. Adams Tool Co., Hartford, Conn.

Dr. Schuyler Skaats Wheeler, president of the Crocker-Wheeler Co., Ampere, N. J., sailed June 14, on the Lloyd steamship *Barbarossa* for a short European trip. He was accompanied by Prof. Francis B. Crocker, professor of electrical engineering at Columbia University, who has been associated with him in business for many years.

Geo. H. Baush will represent Hill, Clarke & Co., machinery dealers, in Philadelphia, with the office located probably in the Bourse. He will take charge of the principal agencies of his company. Mr. Baush was for twelve years connected with the Baush Machine Tool Co., Springfield, Mass., holding various positions, including that of vice-president and general superintendent, and he has an extended acquaintance in the machine tool trade.

George I. Rockwood, the well-known consulting engineer and expert in steam engineering, has been appointed to the professorship of steam engineering at the Worcester Polytechnic Institute. Mr. Rockwood graduated from this school in 1888 and first became prominently known through his advocacy of the high-ratio compound steam engine which has given excellent mechanical results. He has lately been engaged both in consulting practice and in the manufacture of steam engines.

At the celebration of the seventy-fifth anniversary of the Koeniglich Preussische Technische Hochschule, of Hanover, Germany, one of the most prominent scientific institutions in the world, the honorary degree of Doctor of Engineering was conferred on Mr. Ernst Koerting, the noted European engineer, and of the well-known firm of Gebr. Koerting, A.G., Koertingsdorf, Hanover, for his scientific researches and discoveries in gas engines, and other important branches of engineeering. Dr. Koerting lives in Pegli, Italy. He is interested in a number of large enterprises in the United States, among them the De La Vergne Machine Co., of New York, as well as the Schutte-Koerting Co., of Philadelphia, and is at present sojourning in this country.

Niles A. Christensen, the inventor of the Christensen air brake and air compressor largely used on street railway cars, has joined the Allis-Chalmers Co. in an engineering capacity in connection with the manufacture of his air brake and air compressor, the Allis-Chalmers Co. having purchased the exclusive rights for their manufacture and sale. A mechanical plant of original design is being fitted up in connection with the present Allis-Chalmers plant at West Allis, and within the next few months it is expected that 800 or 900 men will be employed in this branch of their business. Mr. Christensen was born in Denmark in 1865 and has had a career of considerable interest, both abroad and in the United States. He came to the United States in 1891, and in 1894 the Christensen Engineering Co. was organized in Milwaukee for manufacturing air brakes and compressors. In 1897 it was merged into a new corporation, the National Electric Co., but this company met with troubles and financial reverses in 1905, which finally resulted in Mr. Christensen's alliance with the Allis-Chalmers Co. as stated above.

* * *

The collecting of stamps of various countries is a widespread fad and the supplying of stamps to collectors has reached the proportions of a respectable business with a number of concerns. The stamp collector is a person who combines intelligence with means and a certain amount of leisure, and naturally is of a critical disposition. It is therefore, of some interest to know how the stamp collectors look upon United States stamps as regards printing, finish, engraving, etc., in comparison with foreign stamps. It is not only interesting, but somewhat mortifying to our pride in American

things mechanical to know that United States stamps are not regarded highly as compared with others. One leading stamp collecting house says that as regards "centering," United States stamps are perforated very poorly in comparison with those of other countries. "By examining a sheet of new stamps it will be found that even if some stamps are perfectly centered other stamps in the same sheet will be badly out. Only a very small percentage of United States stamps are carefully centered and these are regarded as fine." Now, so far as the average user of stamps is concerned it makes not the slightest difference whether the perforations of a stamp are made so that an even amount of white border is left all around, but it does seem that such an important government department as our Bureau of Engraving would take into consideration matters of this kind and endeavor to block their plates and perforate the sheets of stamps so that glaring errors of perforation would not be so marked. It is the little things like this that give foreigners the impression—and rightly, too, perhaps—that the people of the United States are careless and slack in the niceties of finish which are required by people of thorough and artistic make-up.

* * *

FRESH FROM THE PRESS.

THE first number of the *Selling Magazine* has appeared and contains 32 pages of bright business talk, right to the point, upon the marketing of machinery and manufacturing products. The magazine is published by Emerson P. Harris, the well-known broker in periodicals, and is edited by John Kershaw, for several years prominently connected with the advertising department of the Hill Publishing Co.

We have received a copy of a new edition of "A Manual for Engineers" published by the University of Tennessee, Knoxville, Tenn. It is issued in vest pocket form and contains a great deal of condensed information of special interest to mechanical engineers. We are informed by the university that 30,000 copies of this little book have already been disposed of, indicating that it is valuable as a reference book to the busy engineer. The price is 50 cents.

A bound copy of the report of the 24th annual meeting of the American Street Railway Association held at Philadelphia September 27 and 28, 1905, has been received. It is attractively and comprehensively gotten up and contains a number of halftones of officers of the association and of plants and installations referred to in the papers, besides line cuts and diagrams. The official organization for each year since its inception in 1882 is an interesting and valuable feature. The papers read before the meeting, "Application of Gas Power to Electric Railway Service," "Electric Railway Equipment," "Notes of Design of Large Gas Engines with Special Reference to Railway Work" and "The Single Phase Railway System" are printed together with the discussions.

BURNS' PIPE PRICE EXTENDER, arranged by Eugene Burns. 32 pages 3¾ x 6½ inches. Published by David Williams Co., New York. Price 50 cents.

The "price extender" consists of a series of tables for conveniently finding the price of any length of common sized pipe and is based on the present list price for black and galvanized merchant pipe. The price of any length of common pipe is obtained by simple addition. For example, the price of 58 feet 4 inches of 5-inch pipe, whose list price is now $1.45 per foot, is found by referring to the table giving the price of 5-inch pipe in inches and feet up to 100 feet and adding the price of 58 feet and 4 inches, being $84.10 and $0.483 respectively, or a total of $84.583. The same table may be used for lengths longer than 100 feet by simply finding the price for the first two figures of the total number of feet and moving the decimal point to the right as many places as are required for the number of digits and then proceeding with the remainder in the same manner. The price extender is intended, of course, for the use of merchants and dealers in pipe.

THINGS THAT ARE USUALLY WRONG, by John E. Sweet. Published by the Hill Publishing Co., New York, 52 pages, illustrated, price 50 cents.

This little book is in the main a reprint of a series of articles published by Prof. Sweet in the *American Machinist*. Those who have wandered through the works of the Straight Line Engine Co. under the guidance of Prof. Sweet and had explained the various little mechanical niceties and details of construction that he has introduced, not only in the Straight Line engine, but in the tools and appliances used in his shop, will recognize the source of many of the illustrations and comments found in these pages. He has pointed out in his original way many features of design commonly met with in everyday practice, and passed by unthought of by the average mechanic. We believe the book will not only prove entertaining but exceedingly valuable to "mechanical engineers, students, machine designers and inventors and that most of the readers will wish there was more of it," to quote the words and the expressed hope of the author in his preface.

FIRST ANNUAL REPORT OF THE IOWA STATE HIGHWAY COMMISSION. 74 pages 6 x 9 inches, illustrated with 26 cuts.

The enormous importance of good highways to the country at large makes intelligent work of any community for such improvements of unusual interest. For the year 1904 the estimated hauling on the country roads in Iowa was over 32,000,000 ton miles, and this large figure only includes the hauling done in full load. The average size of loads was about 2,100 pounds and the average distance to market about four miles. Good highways are of fully as much importance as good railroads. A good highway enhances the value of farm lands and reduces the cost of carrying products to market. As matters now stand, the average cost of hauling grain from the farm to the nearest railroad station is about equal to that of transporting it 250 miles on the railroad, taking four miles as the average distance of the farm from the nearest railroad station. Within a few years an important discovery has been made regarding the maintenance of dirt roads, and that is dragging them with a split log immediately after every heavy rain. This fills in the ruts, squeezes out the water and grades the track each way from the center so that the road soon dries—and a dry road is usually a good road. The condition of roads before and after working is shown by halftones, and a number of other good cuts of equal interest are given.

TWENTIETH CENTURY MACHINE SHOP PRACTICE. By L. Elliott Brookes. 531 pages 5¼ x 7½ inches and 423 cuts. Published by Frederick J. Drake & Co., Chicago, Ill. Price, $2.00.

This book is a compilation of rules of arithmetic, geometry, mensuration, applied mechanics, and includes chapters on the properties of steam, the indicator, horsepower, measuring devices, machinists' tools, milling machines, gas furnaces, shop kinks, etc. The mathematical section of the book is gotten up in good style, and is a creditable job, but the treatment of tools, machines, screw cutting, etc., is very weak and meager. The cuts are almost entirely large reproduced catalogue cuts and the descriptions are of a perfunctory character, telling things that are either obvious or of no earthly value save to a possible purchaser of the machine, being virtually in fact reproductions of catalogue descriptions. The section on screw cutting gives no rule whatever on compounding, and it is obvious that to most machinists this information is required more than the rule for simple gearing which latter almost any one beyond the rank of the apprentice understands. In short the book is not in the same class with Vandervoort's "Modern Machine Shop Tools," of which it appears in a measure to be an imitation. Many parts of the book could be severely criticised and, for example, mention may be made of a table giving the cutting speeds and feeds of lathe tools. This table gives a roughing cutting speed of 63 revolutions per minute on steel for diameters of 1 inch or less, which means a maximum cutting speed of about 16 feet per minute. For diameters of 3 inches to 6 inches, 48 revolutions per minute are recommended, meaning a maximum speed of about 76 feet. This curious discrepancy is found throughout the table, as for example, in cast iron a roughing cutting speed of 121 revolutions per minute is recommended for diameters of 1 inch or less, while for diameters of 12 to 20 inches 63 revolutions per minute is quoted, the former meaning a surface speed of about 32 feet per minute, and the latter a maximum of about 330 feet per minute for roughing cuts.

MODERN ENGINEERING PRACTICE. In 12 volumes. 6,000 pages, 6½ x 9½ inches and 4,000 illustrations. Published by the American School of Correspondence, Chicago, Ill. Price, $60.00.

This valuable work of encyclopedic dimensions is compiled from the best instruction papers comprising the courses of the American Correspondence School in electrical, mechanical, stationary, marine and locomotive engineering, shop practice, toolmaking, forging, founding, patternmaking, heating, ventilation, refrigeration, mechanical drawing, alternating current work, electric lighting and wiring, telephone, etc. The editor-in-chief is Frank W. Gunsaulus, president of the Armour Institute of Technology. The staff of writers and collaborators include fifty-nine professors, engineers and others, among whom are Prof. F. B. Crocker, of Columbia University; Prof. Esty, of Lehigh University; Prof. Derr, of Massachusetts Institute of Technology; Arthur L. Rice, editor of *The Engineer;* Francis H. Boyer, consulting engineer; Walter B. Snow, mechanical engineer B. F. Sturtevant Co.; Geo. L. Fowler, consulting engineer; Chas. L. Hubbard, consulting engineer S. Homer Woodbridge Co.; Chas. L. Griffin, mechanical engineer Semet-Solvay Co., and many other well-known names too numerous to mention.

It is impossible within the limits of this review to adequately cover or even to give a thorough account of the contents of the various volumes and we shall content ourselves in the main with speaking of them as a whole. The matter is prepared in the well-known style characterizing the work of correspondence schools, being written in clear, intelligent English and with no advanced mathematics. Any young man with a good common school education should be perfectly competent to read these books and understand the principles enunciated. The volumes are, however, intended more as a reference library than as text-books, although they are compiled from the instruction papers forming the courses of the school in the various branches enumerated above and may be used advantageously for study. The same characteristics are typical throughout. Following are the contents by volumes:

Vol. 1—Electricity, Wiring, Telegraph. Vol. 2—Generators, Motors, Storage Batteries, Automobiles. Vol. 3—Electricity, Light, Power and Railways. Vol. 4—Alternating Current Work, Transmission. Vol. 5—Telephony. Vol. 6—Chemistry, Heat, Boilers, Steam Pumps. Vol. 7—Steam Engines, Refrigeration, Gas Engines. Vol. 8—Marine and Locomotive Work. Vol. 9—Patternmaking, Founding, Machine Design. Vol. 10—Machine Shop, Toolmaking, Forging. Vol. 11—Mechanical Drawing and Perspective. Vol. 12—Ventilating, Heating, Plumbing, Carpentry, General Index.

The size of the work—6,000 pages—gives considerable space for the treatment of each subject, so that while no one subject is by any means exhausted it, however, receives a treatment that is far from superficial. For example, the section on machine design, which was of unusual interest to the reviewer, contains 180 pages and in itself comprises a valuable treatise on the subject. The same volume has a good treatment on patternmaking, 138 pages being given to this subject. Metallurgy and foundry work comprise the remainder of the volume. A feature of the work which should not be overlooked is the review questions at the back of each book in which are included a number of pertinent questions for self-examination by those who are using the volumes as a means of education. Volume 10 contains a treatment on machine shop work, toolmaking and forging, and Volume 11 is entirely given over to drawing, the first section comprising 362 pages, being devoted to mechanical drawing, following which is a section on perspective drawing and one on rendering which is of special value to those contemplating studies in architecture.

NEW TRADE LITERATURE.

THE NATIONAL MACHINE TOOL CO., Cincinnati, O. Leaflet of Key Seating Tools. A half-tone cut shows the tools in operation, and a table of net prices for the different sizes is given.

ALLIS-CHALMERS CO., Cincinnati, Ohio. Bulletin 1039. This treats of the subject Electrical Equipment of a Modern Shipyard, being illustrated by half-tones showing types of Bullock motors in use.

THE WELLMAN-SEAVER-MORGAN CO., Cleveland, O. Catalogue of Locomotive Cranes, Buckets and Tubs. Some of the uses of locomotive cranes are given, standard 10-ton cranes are described, a number of engravings showing these machines in service.

PATTERSON GOTTFRIED & HUNTER, LTD., 146-150 Centre street, New York City. Catalogue No. 60 on Screws, including Bolts, Nuts, Washers, Nails, etc. Tables citing dimensions, styles, prices, etc., are given. An alphabetical index is inserted in the back of the book.

INGERSOLL-RAND CO., 11 Broadway, New York. Booklet Form 60A on Quarrying Machinery. Types of Channelers, Gadder, Drills, Displacement Pumps, etc., are illustrated and described in condensed form. Further information will be sent on request to those interested.

INGERSOLL-RAND CO., 11 Broadway, New York. Catalogue 74 A of Compressed Air Pumping Systems. This treats of costs, advantages, field of application, and takes up more specifically the Ingersoll-Rand Return-Air Pumping system and the pneumatic displacement pump. A few types of air compressors are also shown.

THE WELLMAN-SEAVER-MORGAN CO., Cleveland, O., have issued a handsome catalogue on Section "C," Open Hearth and Re-heating Furnaces. The engravings show some of these furnaces installed in a number of the large steel plants. A description of the construction of the product is contained in the text.

J. H. WILLIAMS & CO., Brooklyn, N. Y. New 1906 catalogue of Drop Forgings. New goods and additions appearing in this catalogue are noted on a leaflet which is issued with it. Some views inside the factory are shown. The product is illustrated throughout and specifi-

cations for the different types of wrenches, gages, screws, etc., are given.

B. F. STURTEVANT Co., Boston, Mass. Bulletin No. 132 illustrates and describes Sturtevant economizer installations in the power houses of the Interborough Rapid Transit Co., the New Orleans Railways Co., the Boston Elevated Railway Co., the South Covington and Cincinnati Street Railway Co., and the Burlington Municipal Electric Lighting Co.

THE NEW BRITAIN MACHINE Co., New Britain, Conn. Illustrated circular of the New Britain band saw filer. This device, previously illustrated in MACHINERY, consists of a flat iron table in connection with a saw vise, together with a file attachment, which latter is guided by the table and enables the workman to secure uniform and accurate results.

C. DOERING & SON, 223-229 West Lake Street, Chicago, Ill. Catalogue describing their tin, pressed steel, metal and other products, among which might be mentioned sheet steel shelving, pressed steel shop pans, oily waste safety cans, steel tool racks, lathe pans, etc. A description of the tin plating department and the sheet steel equipment is given.

THE thirteenth number (June, 1906) of the *Progress Reporter*, issued by the Niles-Bement-Pond Co., 111 Broadway, N. Y., supersedes No. 4—September, 1904, and shows the capacity of the Pond Car Wheel Lathe doubled in two years. In one shop there is a record of 518 pairs of car wheels finished in 477 consecutive working hours, and in another shop 14 pairs were finished in 10 hours.

NATIONAL BRAKE & CLUTCH Co., 16 State St., Boston, Mass., have printed a report of tests made on their Cork Insert friction surfaces by J. R. Nichols under the supervision of Ira N. Hollis at Harvard University, Cambridge. This report gives diagrams showing the variation in frictional resistance with varying friction loads. The coefficient of friction for this style of surface is from 0.33 to 0.35.

THE JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J., have issued a pamphlet, entitled Unions for Steam Pipes, which is an illustrated description of the several varieties of unions with suggestions concerning same by W. H. Wakeman, an expert steam engineer and author of several books on steam engineering. The material is reprinted from Dixon's house organ *Graphite*, and the company will gladly send a copy of the pamphlet free of charge to any one interested.

CROCKER-WHEELER Co., Ampere, N. J., Bulletin No. 64 describing Form I motors and generators. These motors are shown driving various machines as sensitive drill, eight-foot boring mill, planer, facing machine, etc. Tables of outputs, net and shipping weights, general dimensions, etc., are given. Bulletin No. 65 points out the new features of C. W. core type transformers. These transformers are manufactured in all sizes up to 4,000 K. V. A., and for all voltages up to 200,000.

PH. BONVILLAIN & E. RONCERAY, Paris-Aubervilliers, France. Catalogue descriptive of the "Universal" system of machine molding patented by Messrs. Bonvillain and Ronceray. There is a general belief among foundry owners that machine molding is practicable only when a great number of castings of the same pattern are needed and where these castings are of a comparatively simple form. The "Universal" system is claimed to be practicably applicable to all forms of patterns without excessively heavy cost for fitting pattern plates, etc.

KING MACHINE TOOL Co., Cincinnati, Ohio. A novel and attractive pamphlet illustrating and describing their new 42-inch vertical boring and turning machine. Among the points to which attention is called is the resilient table drive provided, the clamping device for the tool holders, power rapid traverse in all directions, improved feed changing mechanism, and a single lever control whereby positive feed and a rapid traverse may be engaged in either direction by one lever.

A handsomely illustrated announcement of the Cincinnati Fall Festival and Industrial Exposition held annually in Cincinnati, has been received. This annual exposition was started several years ago mainly advertising the mechanical industries of Cincinnati, but it has developed into a general industrial exposition in which nearly all the various industries of Cincinnati take part. In connection therewith, of course, are many amusements and other features of a purely entertaining nature. Robert R. Reynolds is Vice-President; H. D. Crane, Secretary; and Edward H. Allen, General Manager.

THE INGERSOLL-RAND Co., 11 Broadway, New York City, have issued a number of new catalogues. Bulletins No. 2006 and 2007 on Labor Saving Tools describe "Imperial" pneumatic hammers and "Imperial" piston drills. Catalogue D43 opens with an interesting historical sketch of the rock drill, and proceeds to describe the different types of rock drills and drill mountings. Catalogue 136 has for its subject Imperial Type 11 Power-Driven Air Compressors. The details of construction are gone into at some length and tables of specifications are given. Form 64 describes a number of pneumatic tools, chipping hammers, riveting hammers, rotary drills, piston drills, etc.

THE AMERICAN BLOWER Co., Detroit, Mich., have added several catalogues to the new trade literature. Nos. 192, 195, 196, 202 and 203 are leaflets describing, in brief, "A. B. C." dryers, "A. B. C." Economy buffing hoods, "A. B. C." self-oiling engines, which are lubricated without oil pressure, by pump and gravity feed, "A. B. C." electric disc fans, and "A. B. C." disc ventilating fans. No. 189, on Steel Plate Fans, contains the usual number of engravings, specifications, and convenient tables for reference. No. 190 treats of Blowers. Steel pressure blowers, volume blowers, fan blowers, etc., are described and illustrated. Catalogue No. 194 supplements Nos. 171 and 193 describing engines (types A and E) for small direct-connected generator sets. Disc Ventilating Fans are described in Catalogue 200. These fans are adapted to a variety of purposes, some of these being: ventilation of all types of buildings, removal of smoke, noxious fumes and gases, steam and dust, cooling of overheated apartments, heating and drying, etc.

THE AMERICAN LOCOMOTIVE Co., 111 Broadway, New York, have issued a pamphlet describing electric motor and trailer trucks and illustrating the types of this equipment, designed and built by them. The pamphlet begins with a description of the principles of the designs, of which fifteen are illustrated by full-page drawings. Each illustration is accompanied by a list of dimensions. The designs illustrated include motor trucks for the New York Central suburban service, for the Paris-Orleans, the Schenectady, the Delaware & Hudson, the Brooklyn Rapid Transit, the Buffalo & Lockport, and other railways. The drawings show the construction in detail, rendering it an easy matter to study the designs. In addition to the drawings, nearly all of the trucks are illustrated by reproductions from photographs. Among the details illustrated are cast steel and wrought iron bolsters, truck hangers, spring planks, Brinkerhoff-Doyle wheel hubs and journal boxes with collarless and collar axles. Copies of the pamphlet will be supplied upon request to the American Locomotive Company.

The International Correspondence Schools, Scranton, Pa., have issued a formidable volume of about 1,500 pages containing the names and addresses of 75,000 students who have either been awarded diplomas, or have made considerable progress in the advanced studies of their courses of study. In a letter accompanying the volume it is explained that, besides these 75,000 students, more than 225,000 have completed mathematical, physical and other preliminary subjects. The volume is issued to emphasize the fact that in the last analysis the growth of any educational work must depend upon results, and it is confidently believed that this showing of 75,000 students who have actually made good progress with their studies is not only a favorable one, but a really remarkable presentation of the benefits to be derived from correspondence instruction by those unable to attend regular schools. The management of the International Correspondence Schools feel, and we think with justice, that this system has filled what was a serious gap in the educational opportunities of the country.

THE AMERICAN LOCOMOTIVE Co., 111 Broadway, New York, has issued a pamphlet, "Pacific Type Passenger Locomotives," which describes the Pacific type passenger locomotives built by the company for various railroads; it opens with a description of the type and an outline of its special advantages for heavy and fast passenger service. These advantages, briefly stated, are followed by a description of two forms of trailing trucks which have been used with great success on this type of locomotive. The description is followed by two pages of tables containing in condensed form the leading dimensions of all the locomotives illustrated in the pamphlet; the tables are arranged in the order of the total weight of the locomotives. A typical Pacific type locomotive is illustrated in side elevation and sectional cuts, and cuts of outside and inside bearing trailing trucks are included. The remainder of the pamphlet is devoted to photographic reproductions of locomotives, the opposite pages containing tabular information concerning each design. This is the first of a series of catalogue pamphlets issued by the American Locomotive Co., and it is intended that a series shall eventually include all the standard types of locomotives built by the company and thus constitute a record of their productions.

THE AMERICAN LOCOMOTIVE Co., 111 Broadway, New York, has issued a compilation by Dr. W. F. M. Goss from the recent publication by the Pennsylvania Railroad, describing the locomotive tests and exhibits of that road at the Louisiana Purchase Exhibition. This pamphlet presents, in concise form, an account of the locomotive tests at St. Louis, giving specific information concerning each of the locomotives tested and presenting the results separately for each of the eight locomotives. In the pamphlet four pages are devoted to a description of each locomotive and a discussion of its performance, including a summary of the data of the tests. This is followed by comparisons and conclusions compiled by Dr. Goss from the very elaborate record of the tests recently issued in book form by the Pennsylvania Railroad. While the pamphlet does not add to the information given in the book, it presents the conclusions and comparisons in form for convenient reference. This pamphlet will give a very wide distribution to a summary of the important records of the testing plant at St. Louis. For a more complete record, the book published by the Pennsylvania Railroad, than which there is nothing more valuable in recent literature of the locomotive, may be consulted. Copies of the pamphlet may be had upon application.

MANUFACTURERS' NOTES.

THE NORTHERN ENGINEERING WORKS, Detroit, Mich., have supplied the Toledo & Chicago Construction Co., Kendallville, Ind., with a 12-ton Northern traveling crane.

THE BOWN MACHINE Co., LTD., Battle Creek, Mich., manufacturers of lathe and planer tools, have recently moved into a larger plant, where they will be in a position to fill all orders promptly.

THE firm that has until recently been known as the Norton Emery Wheel Co. has changed its title to the Norton Co. This change was made in view of the fact that the firm no longer uses emery in the manufacture of their wheels, and they felt that the old name was, in a sense, a misnomer.

THE PATTERSON TOOL & SUPPLY Co., Dayton, O., and the W. M. Pattison Supply Co., Cleveland, O., on account of the similarity of their titles, are suffering some inconvenience because of misdirected mail. They request that parties communicating with them in the future will take especial care that all letters are properly addressed.

THE TOLEDO MACHINE AND TOOL Co., Toledo, O., designers and builders of special machinery, sheet and bar metal-working machines, recently booked among other large orders, an order for a drop-forging equipment consisting of one 10,000-pound, 8,000-pound, 3,000-pound, 2,000-pound, 1,600-pound, 1,500-pound, 1,100-pound, and 1,000-pound trimming presses. They also received another large order for twenty-seven presses ranging in weight from 3,000 to 75,000 pounds, for one of the large electrical manufacturers. Each of these machines is to be direct connected motor driven.

THE AMERICAN BLOWER Co., Detroit, Mich., issued invitations to the members of the Detroit Engineering Society on May 25 to visit their plant, and to participate with them at a beefsteak dinner to be given at the Fellowcraft Club. After the dinner a regular meeting of the society was held, at which a paper was read by F. R. Still on "Small Vertical High Speed Self-Oiling Engines." The members of the Detroit Engineering Society responded heartily to the invitation. The movement was initiated by the American Blower Co. with the idea that it would be followed by other manufacturers, and thus give the engineers of the city the benefit of the visits to the various manufacturing plants.

THE ARMSTRONG MFG. Co., Bridgeport, Conn., in order to better serve the needs of their increasing Western business, have opened a branch office and warerooms at 23 South Canal St., Chicago, Ill. The new branch is in charge of Hugh S. Laing, formerly assistant manager of the New York City office. In addition to a complete line of genuine Armstrong stocks and dies, there will be carried a full line of Armstrong's pipe cutters, pipe vises, Bard adjustable bushings, ratchet attachments for die stocks and pipe wrenches. A full stock of pipe-cutting and threading machines will be maintained in the wareroom to enable customers in the district to receive their orders promptly. Buyers of pipe-fitters' tools in the West or central part of the country are cordially invited to communicate with the Chicago office for particulars concerning the Armstrong tools.

THE GENERAL ELECTRIC Co., which has recently established its main office in the Union Savings Bank Building, Oakland, Cal., has leased a suite of rooms in the new Monadnock building of San Francisco which they expect to occupy June 15, 1907. For handling their present business they have leased a block of land in Emeryville, in close proximity to both the Santa Fe and the Southern Pacific Railroad tracks. A temporary building for taking care of stock has about been completed, and work has been started on a warehouse to contain 80,000 square feet, located at the south end of the block. Forty cars of material have been housed and nineteen cars of additional apparatus are in the yards waiting to be unloaded. Cars are being shipped from Schenectady and the stock at San Francisco will soon be complete. The company is in excellent condition to fill orders as rapidly as before the fire.

THE CROCKER-WHEELER Co., Ampere, N. J., have lately received a large number of orders among which might be mentioned: one 450 K. W. 250 volt d. c. generator for the lighting and power of Columbia University; eight 5½ K. W. motor generators for the U. S. Navy gun elevating equipments to Wm. Cramps & Sons Ship and Engine Co., Philadelphia; one 90 H. P. 115 volt, d. c. motor to the Seton Leather Co., Newark, N. J.; three 75 K. W. 250 volt generators for Jos. MacWilliams & Co., Memphis, Tenn.; and equipment for the Lehigh Portland Cement Co., Ormrod, Pa., American Wood-working Machinery Co., Rochester, N. Y.; the M. S. Brown Electric Co., Columbus, O.; the Floyd Wells Co., Royersford, Pa.; Wellman-Seaver-Morgan Co., Cleveland, O. The company have also shipped a carload of their form-L motors, ranging from ¼ to 3 H. P., direct to San Francisco, where they will be used in the rebuilding of the city.